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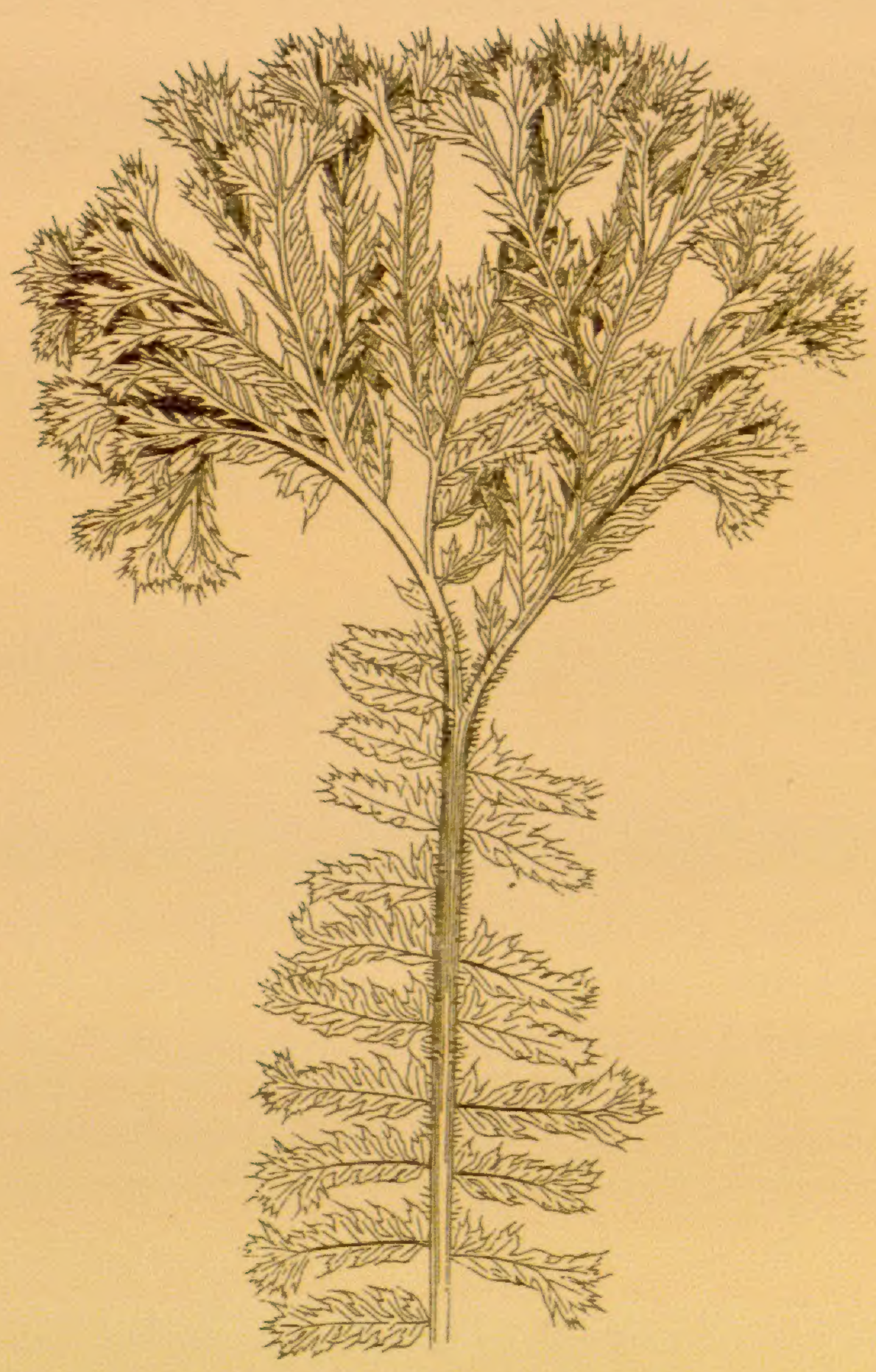
PTERIDOLOGIST

Edited by
Barry A. Thomas



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THE BRITISH PTERIDOLOGICAL SOCIETY

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The BRITISH PTERIDOLOGICAL SOCIETY was founded in 1891 and today continues as a focus for fern enthusiasts. It provides a wide range of information about ferns through the medium of its publications and other literature. It also organises formal talks, informal discussions, field meetings, garden visits, plant exchanges, a spore exchange scheme and fern book sales. The Society has a wide membership which includes gardeners, nurserymen and botanists, both amateur and professional. The Society's journals, the *Fern Gazette*, *Pteridologist* and *Bulletin* are published annually. The *Fern Gazette* publishes matter chiefly of specialist interest on international pteridology, the *Pteridologist* topics of more general appeal, and the *Bulletin*, Society business and meetings reports. **www site:** http://www.nhm.ac.uk/hosted_sites/bps/

Membership is open to all interested in ferns and fern-allies. **SUBSCRIPTION RATES** (due on 1st January each year) are Full Personal Members £15, Personal Members not receiving the *Fern Gazette* £12, Student Members £9, Subscribing Institutions £25. Family membership in any category is an additional £2. Applications for membership should be sent to the Membership Secretary (address above) from whom further details can be obtained. (Remittances made in currencies other than Sterling are £5 extra to cover bank conversion charges.) **Airmail** postage for all journals is an extra £4, or for those not receiving the *Fern Gazette* £2.50. **Standing Order** forms are available from the Membership Secretary.

Front cover: *Polystichum setiferum* Grandiceps as illustrated in E.J. Lowe's 1st volume of *Our Native Ferns*.

Back numbers of the *Fern Gazette*, *Pteridologist* and *Bulletin* are available for purchase from PJ. Acock,13 Star Lane, St Mary Cray, Kent BR5 3LJ, from whom further details can be obtained.

FROM THE EDITOR

Another year has gone by and this is the last Pteridologist of the Millennium. Will there be fern societies left at the end of the next? We all might like to think so, but who knows what the members will be interested in by then. Will there be any discoveries left to be made and how many species will be left in the wild? Will there be sufficient climate change to increase the numbers of species that can be grown in Britain? We just do not know and to pretend otherwise would be madness.

So enough of all that possible crystal gazing and let us concentrate on the here and now. This issue of the Pteridologist contains a range of articles that should please everyone. They are on topics ranging from people and fern collections to distribution and spore longevity. We have a list of selaginellas in one of our National Collections which should encourage some of you to grow these fascinating plants and there is advice on how to ensure that our collections outlive us. There is also an account of the remarkable fern inlays on the Baden Powell desk. Jennifer Ide is continuing to research the New Zealand craftsmen that made the desk, so we can anticipate further discoveries and maybe further articles.

We have some very interesting book reviews here for you which should have you reaching for your wallet, cheque book or credit card. Hopefully next year there will be a review of a new book on cultivating hardy ferns which is being written by our President, who is also still accumulating 'gold medals' for his flower show displays.

I thank all our contributors for their efforts and urge you all to write more for us all. I am always willing to consider articles of any aspect of pteridology, although remember that the real scientific ones can only end up in the Fern Gazette. Any member that does not receive the Fern Gazette could receive a copy of the contents pages with the next Pteridologist if they so wish.

Finally I must apologise for the typographical errors and the poor quality of the colour photographs in the last issue. They resulted from a number of unrelated, but coincident, incidents of which I should have taken more control.

MISSOURI BOTANICAL

SEP 2 2 1999

GARDEN LIBRARY

HYPOLEPIS PUNCTATA (Thunb.) Mett.

Mark Border writes: I received a request through the Plant Exchange Scheme, for a piece of *Hypolepis punctata*. Unfortunately I put the letter away so safely I cannot now find it. If the member concerned would like to recontact me I would be very happy to forward some of this fern, and to anyone else who would like some as it is growing rather well in my garden at:
18 Madeira Drive, Hastings,

East Sussex TN34 2NJ.
(Tel. 01424 432818;
e.mail: mark@border.freeserve.co.uk).

This fern is described in 'A guide to Hardy ferns' as: Throughout Asia to Australasia, Chile. Rather like a small bracken but with rounded sori and covered in small hairs....tends to spread 'too rapidly' in damp positions [Ed.].

MISSOURI BOTANICAL

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THE "WRIGHT" WAY TO COLLECT AND CLEAN FERN SPORES

Barry and Anne Wright, 130 Prince Rupert Drive, Tockwith, York YO26 7PU

The BPS relies on donations of fresh spores every year to maintain the wide variety of species, varieties and cultivars on offer to members. Over 100 requests for, on average 20 packets each, means that we need enough spores to make up at least 2000 packets per year. In order to continue this service we are encouraging members to send in spores. These notes are to help demystify the procedure for collecting fern spores in the hope that more members will feel able to collect spores for the exchange.

EQUIPMENT

Paper to make collection and storage packets, e.g., Clean A4 copier paper.
Small sheet of glass from such as a cheap picture frame.
A craft knife blade - Stanley knife type, (6cm long, trapezoidal.)
Dust mask - if cleaning a lot of spores at once.
A short - 30cm - length of garden cane.
Methylated spirit and cotton wool.

COLLECTING FERN SPORES

Where are they?

Spores are usually found on the underside of fern fronds inside sporangia. These are like drumsticks which are grouped together to form a sorus (Fig. 1). These sori are sometimes covered by an indusium or a flap. This is important when dealing with the cleaning of spores.

When are they ready?

Not all fronds develop sori. Some species produce sterile fronds during the early part of the year and only produce fertile fronds at the end of the season. Catching the plants at peak spore production requires a little patience. Inspecting the plant at weekly intervals as the spores ripen is the most reliable way of ensuring a good harvest. On most species the sorus starts as a small dot on the frond which gradually enlarges. At this stage they are often coloured pale brown. Then, as the spores ripen, they tend to darken to a dark brown or black. When ripe, the sporangia start to split open along the stomium and liberate the spores (Fig. 2). As this proceeds, the empty husks of the sporangia take on a paler brownish colour. This does not mean that all the spores have gone. If you get them at this stage there will still be many sporangia which have not yet released their spores. Also, the tight knotting of the sporangia in a sorus can trap some spores which have been released. It is always worthwhile trying to collect spores from plants where all the sporangia have turned brown to pale brown. The spores of some species like Polystichums tend to stick to the inside walls of the sporangia. Don't give up if you miss the optimum time, it is always worth trying to collect spores at almost any time after the peak of ripening.

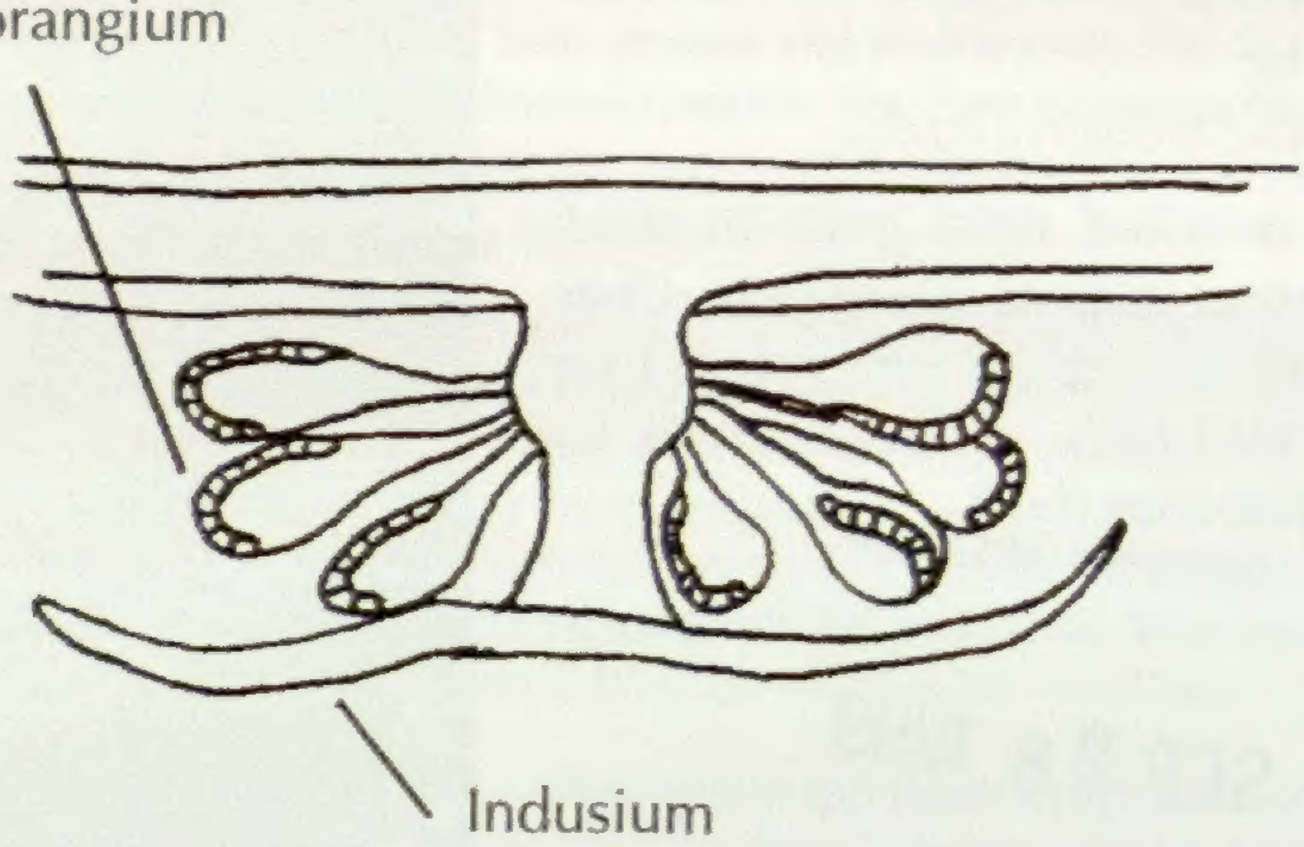

Fig.1. Cross-section through a single sorus

Not all species have black or brown spores. Some species, like Polypodiums, have yellow spores. These are ripe just as the sori start to turn orange or orangey yellow. Polypodiums also seem to produce ripe spores over a long period. Within a sorus, some sporangia shed early and others will take longer to ripen and shed later. Polypodiums are a special case for another reason. In Britain the three common wild species are *Polypodium vulgare, P. interjectum* and *P australe* (Syn *P. cambricum*). These species ripen at different times of year. *P. vulgare* is first, from July/August onwards, followed by *P. Interjectum* from August/September and *P. australe* from December onwards.

When collecting from garden cultivars and wild varieties of these species it is essential to know the correct species name to be able to start looking for ripening sporangia at the right time of year. For example, many of the fancy cultivars are derived from *P. australe*, so don't start to look until Christmas.

Another special case are the short viability species like *Matteuccia, Onoclea* and *Osmunda*. These yield green spores which must be sown fresh or they will quickly lose viability. The spores contain chlorophyll and need to germinate within a few days or weeks of harvest.

How do I collect them?

Whenever the spores are ready they need to be collected. The best way to do this is to put a frond, or part frond, into a paper envelope or similar. We use standard origami style packets. The way to fold these is illustrated at Fig. 3. A4 photocopier paper makes envelopes which hold most fronds likely to be collected. Smaller packets can be made for smaller species. Smaller envelopes of the same design can be used to decant the harvest into for storage until sowing. About the smallest size which is manageable uses a piece of paper 15cm square. Any smaller and they become very fiddly to fold and fill.

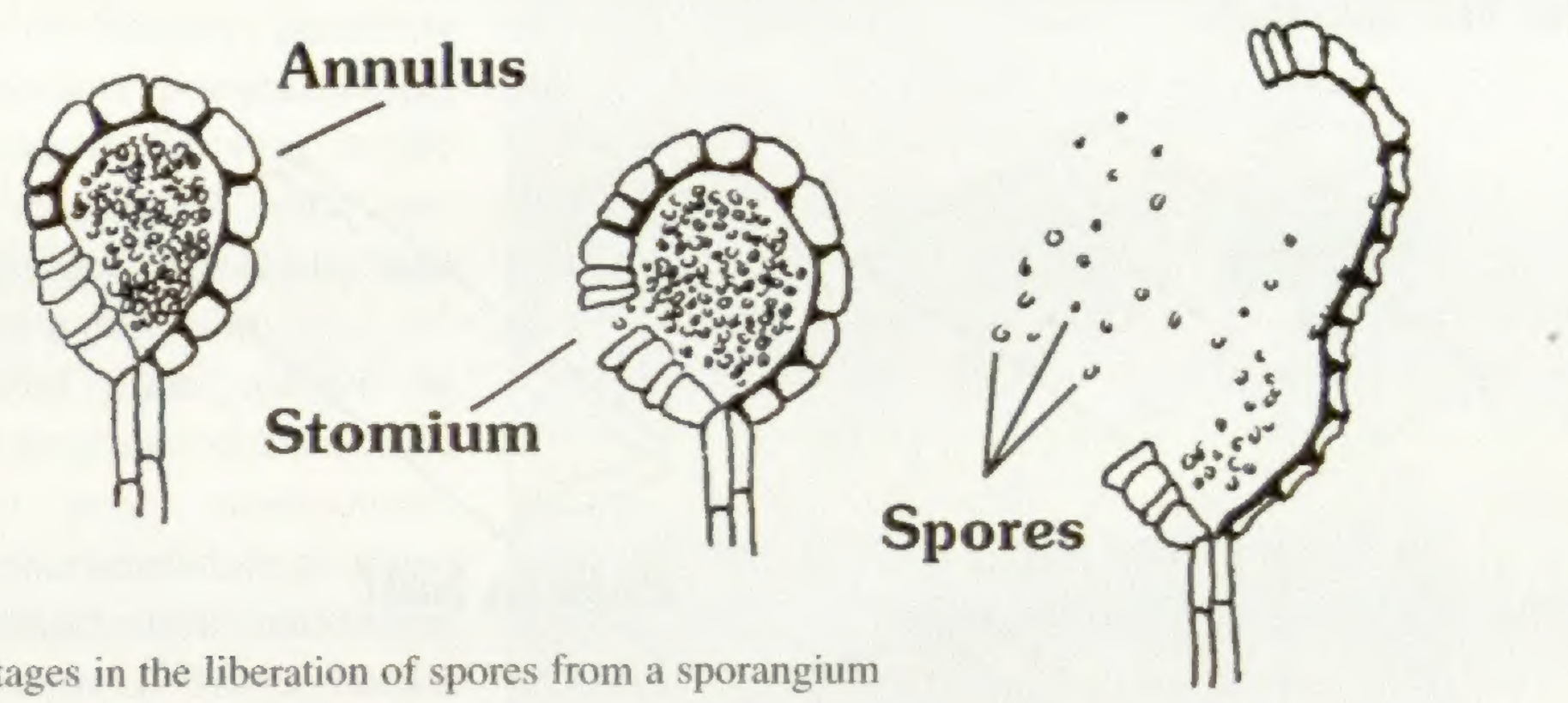

Fig. 2. Stages in the liberation of spores from a sporangium

Open one end of the envelope, cut off a piece of spore-bearing frond and push it in with the length of garden cane. Close the end, label the envelope and store in a cool dry place for a week to allow the frond to dry and the spores to shed.

There is always the strong probability of collecting a contaminated sample. There are always spores of other ferns and moss and fungus spores in the air. These will settle on the fern fronds you collect and form a contaminant in the sample. To eliminate much of this risk you can rinse the frond in clean water to wash off any contamination and shake or blot it dry before putting it into the collection packet. In practice, the proportion of contaminant is usually low and the germinating ferns can usually outgrow them. Cleaning the fronds in this way is probably a bit over-the-top for normal collecting.

What about cleaning them?

As the fronds dry out, more than just spores will be liberated. Indusia and sporangia will also detach themselves and become mixed up with the spores. These need to be removed to leave a nice clean harvest of spores for sowing. This is where the glass and knife blade come in. Open the collection envelope (dust mask optional) and tip the contents carefully onto the glass. Remove the frond and any large fragments. The spores can now be separated from the chaff.

With care, you can blow gently to remove the larger fragments like indusia and sporangia. Then hold the glass and move it from side to side rapidly. The sporangia etc. will tend to move further than the spores and you are left with dust-like spores in the middle, surrounded by a brown halo of sporangia and indusia. Careful use of the knife blade will remove the outer ring of chaff. The pure spores can be scraped off into a new packet and labelled. Store in an airtight box in the fridge until needed. The glass and blade should be cleaned by wiping with cotton wool dampened with methylated spirit between each species to prevent cross-contamination.

If you intend to donate spores for the BPS spore exchange, or another spore bank, clean spores are greatly appreciated. Not only do you know that you are sending real spores, but it also costs less in postage than sending whole fronds in envelopes. As a guide we normally expect to send out between 6 and 10 packets of a species per year, and we keep the spores for three years. This means, ideally, we would like enough spores to fill 30 packets. Any quantity is needed. Your contribution could be one of the many we receive to enable us to make up our 30 packets. For rare species this is doubly the case. Anything is better than nothing. We need spores to maintain the exchange. Common and rare species are always needed to replenish stocks. When sending in spores for the exchange it is important to remember that we are only human and although we can usually deduce the correct names from some of the hieroglyphs written on the packets, neat writing would save us hours of guessing and searching books for likely names for the squiggles we are musing over. Even better, a separate list written in block letters would receive our undying admiration.

A note of caution. Some fern spores have been shown to produce cancers, if exposure is to large quantities over prolonged periods. We use a dusk mask when handling the quantities we deal with. The risk to individuals collecting a few taxa each year will probably be slight. In any case fern lovers must be exposed to moderate spore levels just walking around the garden admiring their collections.

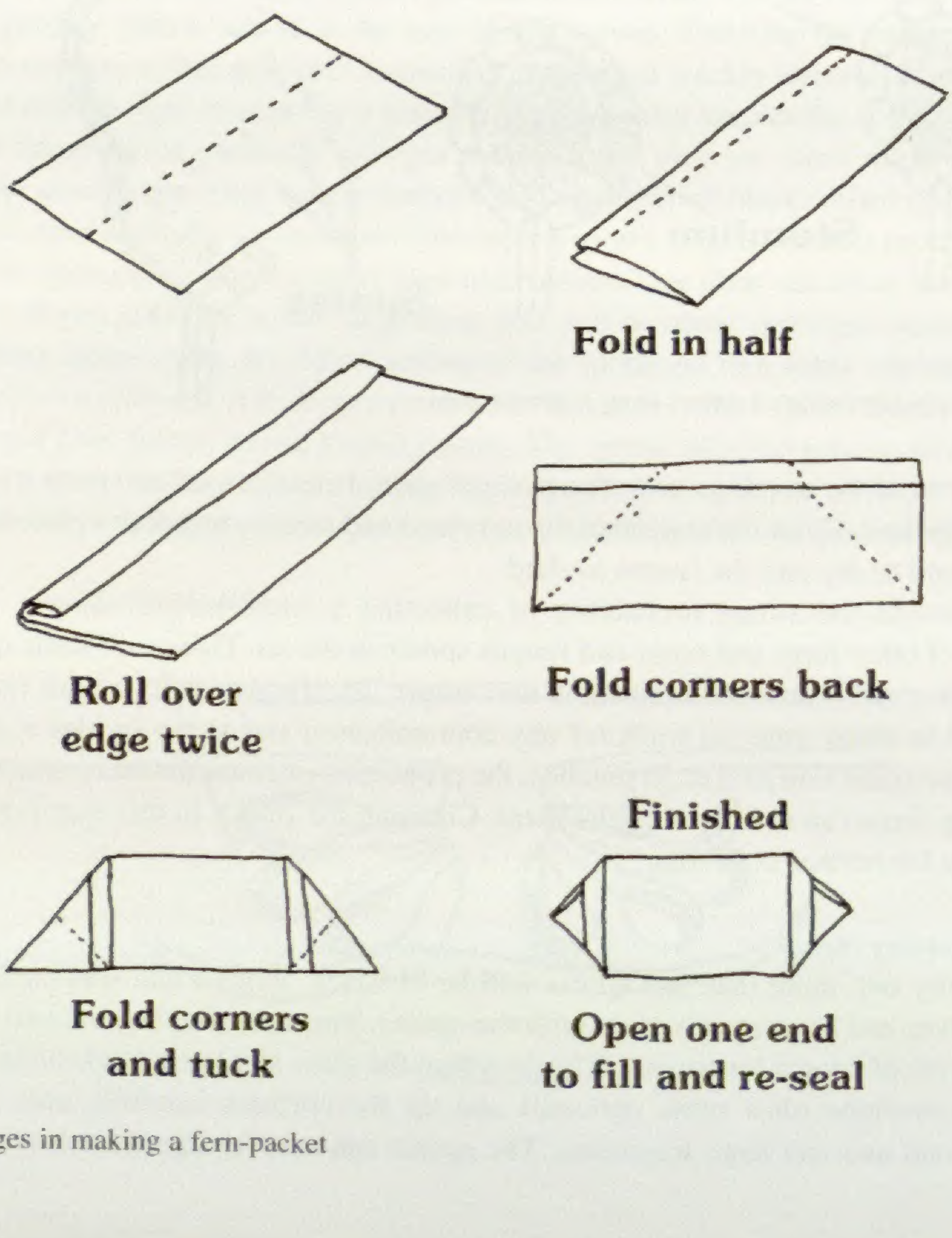

Fig. 3. Stages in making a fern-packet

WALTER SCOTT MBE AND THE "SHETLAND *DRYOPTERIS*"

Ray J. Smith, 184 Solihull Road, Shirley, Solihull, West Midlands B90 3LG

Congratulations are due to Walter Scott the most northern member of the BPS in the UK who was awarded an MBE by the Queen at the Palace of Holyroodhouse, Scotland in 1996 for services to botany.

Walter lives and works in Scalloway, Shetland Isles. A Shetlander by birth he has spent most of his lifetime leisure hours in roaming the hills, lochs, beaches and voes of these northern isles observing and recording the rich and varied flora of this area; and pteridophytes are well up in his order of botanical interest.

He is not averse to taking the occasional sea trip to Fair Isle or Faroe, journeys that raise feelings of trepidation in many of us landlubbers, and has surveyed the majority of worthwhile "outliers" - the many islands making up the Shetland group. Recently he visited Muckle Flugga for the second time, where the UK's most northerly lighthouse stands (not a trip for the faint hearted), and in 1991 set foot on the Out Stack; you cannot get any farther north in the UK than that!

He is co-author, with Richard Palmer from Didcot, Oxon, of the book "The flowering plants and ferns of the Shetland Islands", published by The Shetland Times Ltd. in 1987 which without doubt is the definitive botanical work on this area, and will continue to be so for many years to come. Unfortunately, and significantly, it is already out of print.

For many years Walter has been endeavouring to obtain a positive identification of a crisped, congested male fern which grows on steep grassy sea banks on the eastern side of the south Shetland Mainland. Fronds have been distributed among a number of Society members with varying responses. A form of *Dryopteris filix-mas* is the general consensus with var. contorta crispa, or *D.filix-mas* x *oreades* a possibility.

A trial plant, grown in Solihull England over a period of 9/10 years, maintained similar characteristics to those on Shetland with maximum frond length of 58cm. unlike the more pliable and usually longer fronds of *D.filix-mas*, suggesting geography or environment has little effect on its development. Other features which appear to differ from *D.filix-mas* are sori that end abruptly about a third to half way down the frond, and more scales at the base. It does not posses the dark junction where the pinna meets the rachis, predominant in *D.Affinis*.

Fig. 1 Walter Scott contemplating a fern on Shetland

Fig. 2 A herbarium sheet of a frond from the *Dryopteris*

GROWING XEROPHYTIC FERNS

Martin Grantham
1254 64th Street, Emeryville, California 94608-1105, USA.

I have a special fondness for ferns. They are masters of form and foliage. Morphologists have questioned the evolutionary relationship between the fronds of ferns and the leaves of flowering plants (hence the parallel terminology of stipe/frond and petiole/leaf), but if fronds are not leaves, then leaves have been outdone! The range of color and form is spectacular. The elegant combination of black lacquer stipes with new blades of flamingo pink found in the tropical *Adiantum macrophyllum,* or the fiery iridescence of the temperate *Doodia aspera*, hacksaw fern, approach the excesses of flowering plants. Form varies from the frothy, impressionistic *Adiantum raddianum* 'Gracillimum,' with ultra-fine dissection, through the bold integrity of *Asplenium nidus*, the bird's-nest fern, to the modernist asymmetries of *Platycerium*, the genus of staghorn ferns .

Ferns have greater potential for horticultural use and grow in a wider range of situations than most gardeners would believe. Many exceptional ferns "put to the test" have shown they can perform well in difficult garden situations. *Blechnum penna-marina* has been a successful edging plant and ground cover, tolerating occasional foot traffic and producing mats thick enough to inhibit weeds. Some, like *Microlepia platyphylla*, have shown a tolerance for the heavy root competition of large trees. Others, like *Mildella intramarginalis*, can perform beautifully in dry shade. Still others, like the elegant *Aleuritopteris argentea,* are perfectly content growing between the stones on the vertical face of a rock wall.

BREAKING THE STEREOTYPES

Especially intriguing among ferns are those from drier environments, the ferns called variously rock, desert, or xerophytic ferns (for their habitat) or cheilanthoid ferns (for an appearance like or relationship to the genus Cheilanthes, the lip ferns.) These names refer to several related genera in the family Pteridaceae, a family including the wet-growing maidenhair ferns as well. The xerophytic ferns have representatives distributed widely over the globe, but are particularly diverse in the American Southwest and Mexico. Upon learning of these ferns I thought: Why do they bother? Don't flowering plants do much better at this sort of thing? These ferns do show only a limited range of adaptations for dry habitats. None, for instance, have developed succulence in any of their parts. The rhizome is generally thin and wiry with no capacity to store water, although it may contain more sophisticated water-conducting cells or even vessels as in flowering plants. The roots remain, as in most ferns, delicate threads laid down by a single meristematic apical cell.

It is the aerial portions of these ferns that show many adaptations characteristic of plants suited to dry habitats. In *Pellaea* the fronds may be finely dissected with small leaflets, or pinnules, as in *P. mucronata* and a few others. This reduces heating in bright sun, but also gives these tough ferns a delicate appearance. The leaflets are of heavy substance with a waxy cuticle and strongly recurved margins designed to conserve water and protect developing sporangia. *Notholaena* shows heavy wax production on the underside of the fronds, thus reducing transpiration and adding a striking chalky-white or yellow coloration beneath. *Cheilanthes* and *Astrolepis* are masters of pelage, or hairiness; protective hairs (one cell in width) or scales (more than one cell in width) may cover all portions of the fronds, giving them a silvery or tawney appearance. The scales on the underside of the fronds may be a different color from those above, yielding contrasts between silver and cinnamon or chocolate. Young fronds lose greater amounts of water and are more vulnerable to damage during dry periods; many xerophytic ferns avoid this problem by entering a heat-induced summer dormancy. Some xerophytic ferns, like *Mildella intramarginalis* (fig. 1), are desiccation tolerant, with a special physiology allowing for survival during extremely dry periods. At such times the fronds of *Mildella* curl up tightly as they dry, their fresh green color changing to a dull olive. They appear to pass the permanent wilting point, beyond which foliage cannot be revived. But in this case, if water becomes available in a reasonable length of time, fronds that appear lifeless may revive completely over

two or three days. This ability also exists in *Cheilanthes*, *Bommeria*, *Argyrochosma* and is particularly well developed in *Pellaea*. Small plants of *Pellaea* have withstood as much as five years of desiccation in experiments.

Some foliar characteristics of xerophytic ferns may be adaptations to exposure rather than to xeric conditions per se. Xerophytic ferns generally grow in open, dry, rocky areas at middle elevations where they experience high light intensities, wide temperature fluctuations, and persistent wind. Alpine and coastal strand habitats are also characterized by extreme exposure and plants from these habitats share some of the same foliar features as xerophytic ferns, such as coverings of hairs or scales which serve to screen out or reflect excess light, insulate against temperature extremes, and create a boundary zone of still air which reduces drying and chilling by the wind. Such coverings may also serve as a moisture reservoir for the leaf.

REPRODUCTION

Reproduction by spores would hardly seem an advantage in dry regions. Yet this might, in fact, make xerophytic ferns more successful than flowering plants at finding the restricted microhabitats, in otherwise dry terrain, that provide enough water for establishment and completion of the life cycle. Spores are released by ferns in far greater numbers than are the seeds of flowering plants and, because of their small size, are much more widely dispersed. If a particular rock formation is arranged so that precipitation (rain or dew) is harvested and funneled to a favorable spot, it won't be long before these same rocks are insulating the roots and rhizomes of ferns from midday heat. (Rocks have been shown to provide a temperature reduction of up to 15°F in the field.)

The spores produced by ferns from dry habitats tend to be deeply pigmented with phytomelanin, closely related to the melanin which protects our own skin from UV damage. They are long-lived in storage and probably relatively long-lived in nature. (There is a broad range of spore "shelf life" from a matter of days in green-spored *Osmunda*, to under a year for *Cyathea*, up to a record of seventy years for *Plagiogyria*.) Although xerophytic fern spores may be exceptionally tough, the gametophyte or prothallus that emerges from these spores is delicate and tiny. This stage in the life cycle of a fern consists of a central pad of several cell layers and two lateral wings, each a single cell layer thick. At the growing tip is a notch which gives the entire structure the shape of a heart. The role of the gametophyte, as the name indicates, is to produce gametes; the male gamete is motile and requires a continuous film of water in order to reach, and fertilize, the sessile female gamete. Fertilization results in the growth of a sporophyte (so named because it eventually produces spores). The sporophyte is the stage we recognize as a fern.

REPRODUCTIVE QUIRKS

How do these delicate, water-dependent life stages and events occur under xeric conditions? Basically, the answer comes down to speed: an accelerated development or the elimination of certain steps. Alternatively, some fern gametophytes, as in *Pellaea*, can enter a state of physiological "suspended animation" during dry periods. The only structural adaptation to drier habitats I have noticed in the gametophytes of xerophytic ferns is the production of wax in *Notholaena* (fig. 2). which may aid in reducing water loss.

Accelerated development may allow all vulnerable life cycle stages to occur during a relatively brief and perhaps rare damp period. Among ferns in general there is a broad range for the minimum time required to progress from spore to sporophyte. Xerophytic ferns are among the fastest, producing sporophytes in as little as six weeks in my experience, while slower ferns may require two years or more. To save time many xerophytic ferns simply skip fertilization. An embryo forms directly from the gametophyte's central pad of tissue. This is called "apogamy" which means "without gametes". In *Pellaea*, gametophytes may have the ability to survive long periods of extreme desiccation during which they are quiescent. This would allow development to proceed cumulatively over sporadic wet periods.

DISPLAYING XEROPHYTIC FERNS

With their beauty, interesting biology, relative obscurity among the general public, and unknown horticultural potential, xerophytic ferns are ideal for special displays An experimental display was tried at the University of California Botanical gardens, Berkeley. Collection development among ferns of all kinds at the garden has been aided by pteridologist Alan Smith working at the UC Berkeley Herbarium, but it was through the prodigious collecting efforts of former UCBG horticulturist Sean Hogan that the holdings of xerophytic ferns burgeoned between 1991 and 1994. Sean successfully placed a number of these ferns in the New World Desert plantings; it is delightful to see just how well most have performed as companion plants for cacti! The greater part of the collection, however, was housed for some time in an area closed to the public. I felt these unusual ferns, which performed so well under unfern-like conditions, should be highlighted in a display of their own so that we might increase awareness and interest in these handsome plants, while learning more about their cultivation requirements.

The site chosen was somewhat controversial. There was doubt among the Garden's staff that any plant, let alone ferns, could withstand the harsh southwestern exposure. The existing shallow redwood planters allowed a lethal buildup of heat in summer so that nothing planted in them had performed well. From what I had observed in our New World Desert plantings and in nature, I thought the xerophytic ferns were worth trying, if we could construct a deeper, larger planter with thick, insulating walls and with rocks among which to place the plants. To make light of the dire predictions, I referred to my proposed display as "the fern frying pan." But I also incorporated flowering plants selected to reinforce and complement the adaptive strategies shown by the ferns, to provide visual interest, and to hedge my bets.

We used a quick-draining soil mix with the following formula: 30% firbark compost, 30% coarse sand, 20% 3/8" granite gravel, 10% expanded shale, 10% fine river sand. An automatic subsoil irrigation system was installed to supplement overhead hand watering. I added as much lichen-covered Sonoma field stone as my back could bear to place with the plants. The ferns were planted in July 1996, but would have much preferred that we wait until November!

The display was laid out for approximately 30 species of xerophytic ferns in 8 genera, including:

Cheilanthes (from the Greek cheilos, margin, and anthos, flower), widely distributed and the largest, most diverse genus of xerophytic ferns with well over one hundred species, many of which are easy to grow. The taxonomy of this group is said to be "unstable" so horticulturists should be prepared for future name changes. Especially successful have been *C. bonariensis* (fig. 3), *C. buchtienii*, *C. eatonii* (fig. 4), *C. myriophylla*, *C. pruinata*, and *C. tomentosa*, all tending to remain in tight clumps, as well as *C. lindheimeri* (fig. 5) and *C. wrightii*, with long creeping rhizomes.

Astrolepis (from the Greek astros, star, and lepis, scale) a much smaller genus of perhaps 8 species with star-like, branched scales. The fronds are basically pinnate, long, narrow and held more or less erect. All tend to remain in tight clumps. *A. sinuata* (fig. 6) has a wide distribution in nature and tolerates a range of light, soil, and water conditions in cultivation.

Bommeria (named for pteridologist Jean-Edouard Bommer) a genus of only four species with beautiful pedate fronds covered with glistening hairs and raised just above the soil line. *B. hispida* would make an elegant ground cover with rhizomes that creep long distances and grow quite deeply. Fronds can be damaged at temperatures below 25°F but will be renewed from the deep rhizomes.

Notholaena (from the Greek nothos, false, and chlaena, cloak) a genus of about twenty-five species that produce an appealing waxy or farinose layer on the underside of the fronds. All tend to remain in tight clumps. This genus can be moderately difficult to grow, but the most successful have been *N. candida* (fig. 7), with fronds bright white beneath and deep green above, and *N. copelandii* with a dusting of wax even on the frond's upper surface.

Pellaea (from the Greek pellos, dark) a diverse genus of about forty species bearing handsome fronds on dark, lustrous petioles, with recurved margins and a waxy cuticle often of an attractive blue-green color. The fronds can be brittle and vulnerable to mechanical damage. In some the senescent and dead fronds remain firmly attached and it is usually not practical to attempt

removal. Most tend to grow in slowly spreading clumps as do those mentioned here, but some develop long-creeping rhizomes. Especially successful have been *P. atropurpurea*, *P. mucronata*, and *P. truncata*.

Argyrochosma (from the Greek argyros, silver and chosma, powder), a genus of about twenty species often has a white farinose layer on the underside of the fronds, as in *Notholaena*, but has leaflets that resemble those of the more finely dissected species of *Pellaea* to which it is more closely related. These beautiful plants are easily lost when the rhizomes (which grow upward and seldom branch) are subject to heat or mechanical damage.

Among the flowering plants originally featured with the ferns was *Salvia cedrosensis*, which protects itself from exposure with a dense pubescence of branched hairs. It is a perennial subshrub, rare in cultivation and endemic to southern Baja California and Cedros Island. In summer the foliage is a bright, heat-reflecting, white. It had failed repeatedly during winters here when planted in our native soils. The perfect drainage and harsh exposure of the fern display allowed it to thrive through a rather wet winter, but quite unexpectedly irrigation during the warm summer months proved lethal and has all but eliminated this plant from the display. The survivors include: *Leucophyllum*, shrubs from warm , dry climates that produce numerous lavender to violet flowers in summer but that generally need more heat than is found in the Bay area; *Dalea*, a small, shrubby species with heads of rose-purple and pink pea-like flowers and pinnately divided leaves that disappear among the surounding fronds; *Agave*, several dwarf species placed to discourage sitting and *Echeveria*, several species, of which the best performer has been *E. runyonii* . The echeverias show a waxy bloom that reduces water loss as in the fronds of *Notholaena*. They also show leaf succulence, a trick beyond the evolutionary capabilities of most ferns. Interestingly, succulence in ferns (although not taken to the extreme shown by cacti and euphorbias) is most often exhibited by epiphytes growing in the montane forests of tropical regions. Epiphytes occupy a niche also prone to water stress.

GROWING TIPS

In working with the xerophytic ferns it has become apparent that many are among the easiest ferns to propagate from spores (given a little extra care in the early sporophyte stage during the transition to greater exposure). Mature plants can also be divided with excellent success in fall. They can be surprisingly adaptable, as demonstrated by the splendid specimens of *Cheilanthes lindheimeri* (from Arizona, Texas, New Mexico and Mexico) thriving in both our New World Desert, with minimal summer irrigation, and our Eastern North America section, under heavy irrigation. Drainage, bright light, and good air circulation are crucial requirements for good performance. When grown in containers the soil must never dry out completely. In our New World Desert many cease growth with the onset of summer heat, actively growing from fall through spring. Protected in a lathhouse with regular watering, most will grow year-round. Because they come from seasonally dry areas where high salt concentrations may be found in their native soils, they are more tolerant of salts than ferns from wetter habitats, and can be fertilized more heavily.

Because xerophytic fern spores store well and require little space, it is easy to back up our entire collection with stored spores. I routinely collect spores of all our desert ferns when they first become fertile. This proved useful when, two years ago, we lost our single specimen of the infrequently collected *Pellaea mutabilis*. In this case I was able to produce seventy-five young ferns, not only replacing the lost garden plant, but allowing us to offer this unusual fern in future plant sales. Through the creation of xerophytic fern display, as well as special distributions, and public offferings, I hope that these beautiful plants may become more widely known and readily available for garden use.

Fig. 1 *Mildella intramarginalis*

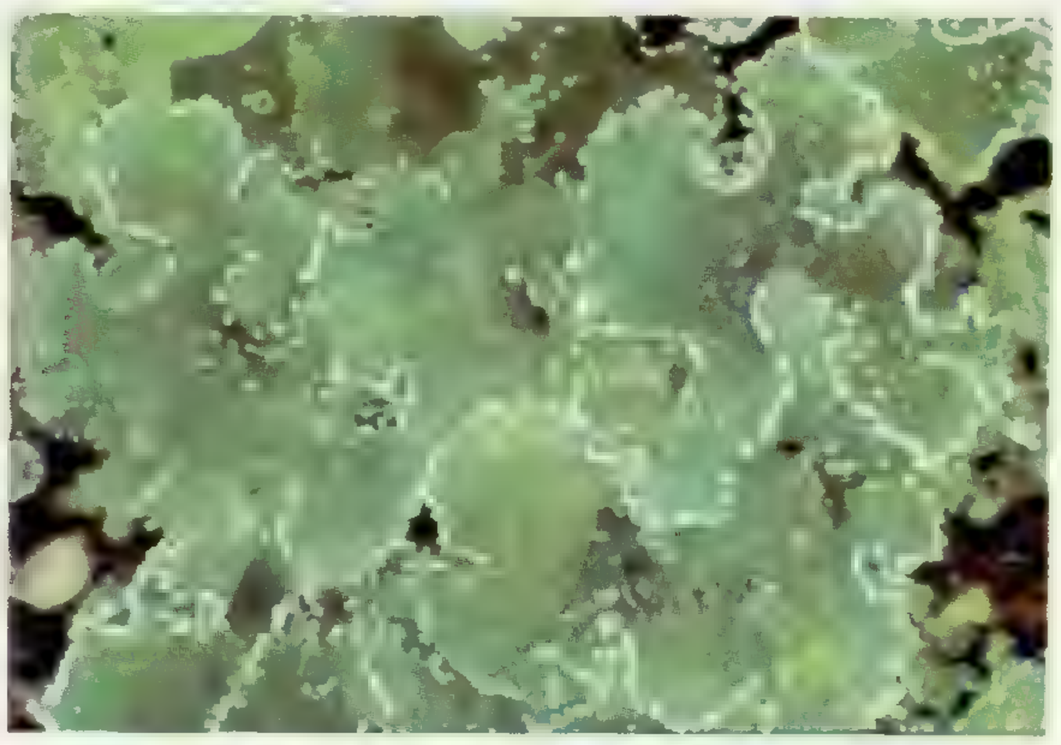

Fig. 2 A prothallus of *Notholeana candida* showing extrusions of wax

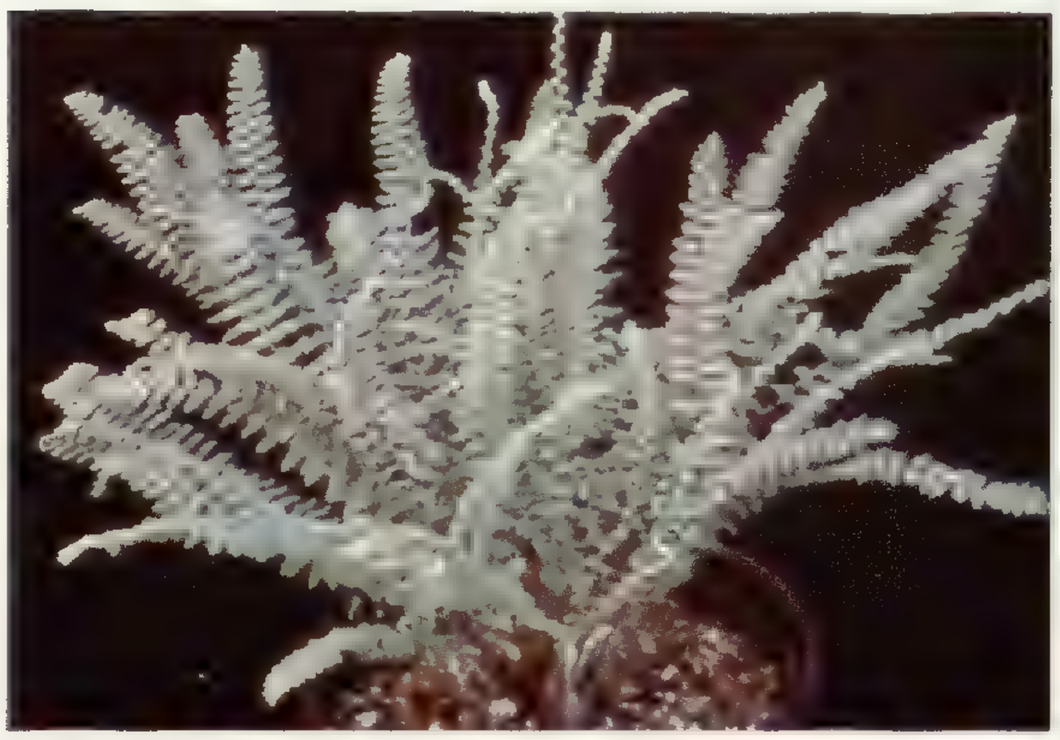

Fig. 3 *Cheilanthes bonariensis*

Fig. 4 *Cheilanthes eatonii*

Fig. 5 *Cheilanthes lindheimeri*

Fig. 6 *Astrolepis sinuata*

Fig. 7 *Notholaena candida*

BOOK REVIEWS

A large number of excellent books on pteridophytes have been published recently. Some have been reciewed in The Gazette, others have not yet been reviewed [Ed.].

MARTIN RICKARD

FERNS OF BRITAIN AND IRELAND by C.N. Page. 1997. Cambridge University Press. Second edition. xx & 540 pp., Numerous unnumbered photographs, maps and silhouettes. 250 x 175mm. Hardback £90. (ISBN 0 521 58380 2); paperback £40 (ISBN 0 521 58658 5).

The first edition of this book was published in 1982 and reviewed by me in the *Fern Gazette* in 1983, Vol. 12, 6, pp. 307-8. No other book on British Ferns and their allies, not covering cultivars, could match the first edition for sheer volume of information. In the intervening 15 years Christopher Page has accumulated much additional information and an additional nine taxa new to the British flora. This edition now exceeds the first by about 100 pages and, therefore, clearly surpasses all comers in size. It is not a cheap book, but price per word is very reasonable!

The nine new taxa recognised are: *Asplenium adiantum-nigrum* subsp. *corrunense*, *A. trichomanes* subsp. *pachyrachis* (now *Asplenium csikii*), *Equisetum x bowmanii*, *E.* x *mildeanum*, *E.* x *willmotii*, *Pteridium aquilinum* subsp. *atlanticum*, *P. aquilinum* subsp. *fulvum*, *P. pinetorum* subsp. *pinetorum* (syn. subsp. *latiusculum*), *P. pinetorum* subsp. *osmundaceum*.

This makes a total of 113 taxa recorded for the British Isles (if my calculations are correct). The author additionally puts a question mark against a tenth new taxon, *Asplenium* x *adulterinum*, the hybrid between *A. viride* and *A. trichomanes*. It would indeed be exciting if this hybrid could be confirmed. I suspect these additions will be unknown territory to most field pteridologists. To have these concepts explained is, therefore, very welcome, but I wonder what the general consensus amongst *Pteridium* specialists is towards this proliferation of taxa? Surprising to me is the omission of *Asplenium trichomanes* nothosubsp. *staufferi*, the hybrid between *A. trichomanes* subspecies *pachyrachis* and *quadrivalens*. Was this a mistake or was it intentional ?

Compared to the first edition several features have been cut: no doubt in the cause of economy. Notably there is no full taxonomic list of all the ferns and allies recorded for Britain, no list of naturalised species, no notes on cultivation or conservation, nor suggestions for future study. I regret the axing of the taxonomic list and naturalised species list but I agree the other sections were low priority in a book devoted to the field study of ferns. I am very pleased to see the map of oceanity has a modified caption, so it is now easily understood.

The main taxonomic section of the book follows the same format as before except that the primitive ferns (*Ophioglossum*, *Botrychium* and *Pilularia*) have now been sunk into the main alphabetical section, only the fern allies being treated separately. This taxonomic section has been enlarged considerably. Quite a few species accounts, although far from all, have been supplemented by European distribution maps and illustrations of young frond stages (taken from Orth, 1938). Silhouettes are the principal illustrations, almost all have been modified since the first edition, often using different fronds. In general they are in a heavier print than before with the washed out appearance of the first edition in most cases removed. This is usually to good effect but I sometimes wish the sori could be seen as was often possible in the first edition. Sori are key diagnostic characters and illustrations at generic level would be useful, if not essential. There are a few sketches in the chart keys in the introduction but the sori of several genera are not illustrated, e.g. *Phyllitis*, *Gymnocarpium*, *Oreopteris*, etc. A welcome addition has been the inclusion of some very good quality black and white photographs. I was particularly pleased to see one of the locality for *Ophioglossum lusitanicum* in the Scilly Isles, as well as photographs of many key diagnostic features, for example the shot of the upturned margin of the frond of *Dryopteris aemula*. There is also a fine photograph of *Woodsia ilvensis* in Scotland which looks familiar but I cannot think where I have seen it before! The chart keys, and a multi-access key, usually work down to generic level although there are no keys to specific level, hopefully the silhouettes make them unnecessary. The small distribution maps of the first edition are reused without any apparent modification. These maps are useful for a general idea

where certain taxa may be found but some omissions are unfortunate, e.g. *Adiantum capillus-veneris* in South Wales and *Dryopteris aemula* in South east England.

Some species have received very thorough coverage, in particular *Asplenium adiantum-nigrum*. As mentioned above Chris Page recognises subspecies *corrunense*. This is the serpentine form thought to be *Asplenium cuneifolium* a few years back until Dr Anne Sleep showed it was only a form of *A. adiantum-nigrum*. There are numerous illustrations of subsp. *corrunense* from many sites, although confusingly the figures are not labelled as being this form. Some fronds illustrating how tantalisingly close *A. adiantum-nigrum* can come to *Asplenium onopteris* are also very welcome. True *A. onopteris* is illustrated in its own section.

In view of the research being carried out by Heather McHaffie at Edinburgh on *Athyrium flexile* in Scotland, it is not surprising to see a full coverage of the problems of this taxon given here. The inclusion of many silhouettes showing the range of form of this species together with some of the intermediate forms is quite thought provoking.

Cystopteris dickieana is another problematic species here given a treatment to which I can subscribe. The plant from Aberdeen alone is considered as true *C. dickieana*. Plants morphologically similar to *C. fragilis* but with dickieana-like spores are treated separately under *C. fragilis*. The author speculates on the possibility of creating a new taxon for this form, an idea that appeals to me and most other fern growers!

Inevitably that 'bete noir' of British pteridology, *Dryopteris affinis* looms large. In this edition the three principal forms are illustrated in silhouette and photograph, but I think the text will probably be the most helpful guide to recognition of these difficult subspecies. The morphotype concept is not used here. Elsewhere the coverage of *Dryopteris* is very good. I am pleased to see that at least one atypically large frond of *D. oreades* has been illustrated, but I am sorry to see the awful sketch of *D. dilatata* has been retained - it looks more like *D. cycadina*.

Nomenclature used provides one or two surprises. *Phyllitis scolopendrium* in the first edition (for *Asplenium scolopendrium*) and *Ceterach officinarum* (for *Asplenium ceterach*) have both been retained in contrast to the position of most modern authors, but I am disappointed to see *Polypodium australe* once again sunk in favour of *P. cambricum*. Taxonomically correct it may be, but this name is totally unacceptable and confusing to fern growers. I had hoped the author would continue to resist the change

The silhouettes for the various taxa of *Polystichum* have been revised. The specimens of *P.* x *illyricum* are much improved but the choice of luxuriant fronds of *P. setiferum* obscures some of the detail shown well in the first edition. I was very interested to see the setose population of *P. lonchitis* well illustrated Few, if any true cultivars are covered in this book but this setose form does look very handsome.

As hinted above, the coverage of bracken is very comprehensive. In the first edition it ran to five and a half sides, here it covers 27 pages! Fifteen years ago only the base *Pteridium aquilinum* was recognised. Now we have 5 distinct taxa. I look forward to getting into an area where these different forms grow to try and familiarise myself with the various concepts. I am sorry no dichotomous key is given here.

Trichomanes speciosum is well covered but I would have liked to see a photograph of the gametophyte plus possibly a habitat photograph, this is something to be looked for in many parts of Britain with a fair chance of success. Surely it is still badly under-recorded

The last part of the book is given over to a very comprehensive account of the fern allies. *Equisetum* is inevitably well covered since the author is one of the foremost authorities. The lycopodiaceae are also discussed at some length, especially *Diphasiastrum* x *issleri*. Chris Page argues that southern populations assigned to this taxon may be correctly named, but he wonders if those at the Scottish sites might be the hybrid between *D. tristachyon* and *D. alpinum*. I must admit these arguments are tempting, although I remain to be convinced that these plants are anything other than etiolated specimens of *D. alpinum*. The book is completed with a comprehensive bibliography.

Overall this book has been a pleasure to review. It is full of information, some of it thought stimulating. The author has not fought shy of problem areas. He may have cast caution to the wind at times but the end product is very readable and, apart from where the author admits he is speculating, the end product is a factually safe work. At £40 for the paperback edition I think it is good value.

While browsing in the book shop at Kew Gardens recently I came across the following two books which seem to have escaped review in *The Pteridologist*. As both are currently available short reviews are given here.

FERNS OF HAWAII by Kathy Valier, Honolulu. 88 pp, 27 col. Photos, numerous b/w photo 1995. ISBN 0-8248-1640-4.
It is remarkable that an island such as Hawaii, with a fantastic fern flora, has never had a comprehensive account of its ferns published. This BOOK will not, unfortunately, fill that void but it is nevertheless a useful introduction to the local ferns.

I have come across two other booklets on Hawaiian ferns, *Ferns of Hawaii National Park* by Douglas Hubbard, 1952 - very much an illustrated introductory guide; and the even older, *Revised list of Hawaiian pteridophyta* by Carl Christensen, 1925 - an non-illustrated technical account. The present book falls into the same category as the former. While still only an introductory account, it does represent a step forward and the photographs are good to excellent, with many in colour. There are short species descriptions, which are no doubt useful for those lucky enough to try them out in the field, and there are useful introductory sections. All round I am happy to recommend it for any would be explorers of these bewitching islands.

FERNS IN COLOUR, AUSTRALIAN NATIVES AND EXOTICS by David Jones, Reed. Pp. 96. 43 col. Photos, 1985, reprinted 1991, £8.50.
Similar coffee table books written jointly by Chris Goudey and David Jones have been reviewed in *The Pteridologist* before. This offering is purely a collection of magnificent colour photographs of ferns apparently chosen at random. Few are hardy in Britain, but for growers of tender species this little book will wet the appetite.

FRED RUMSEY

BRITISH PLANT COMMUNITIES VOL. 4 . AQUATIC COMMUNITIES, SWAMPS AND TALL-HERB FENS by J.S. Rodwell (ed.) 1995. Cambridge University Press, Cambridge. Hardback £65.00, (ISBN 0 521 39168 7). paperback £24.95, (ISBN 0 521 62718 4).
The fourth of five volumes which aim to comprehensively classify, name and systematically arrange the vegetation of Great Britain, this work deals with those communities of aquatic and swampy environments and overlaps therefore to a certain extent with the earlier treatment of mire vegetation. In the introduction the authors acknowledge the dearth of descriptive phytosociological work in these rather difficult environments, with the resulting poorer and more patchy coverage than elsewhere in the series therefore achieved. As a common criticism of this series has been one of difficulty in practical use in the many parts of the country not well represented by the sampling regime this does not bode well. The more limited range of taxa typically present in these aquatic environments, with communities often dominated by one, or two species, may in part overcome this; time and use will tell!

A total of 52 communities are recognised; the 24 aquatic communities are, in a break with the dichotomous keys employed elsewhere, being simply identified from a synoptic table of diagnostic species. The *Isoetes lacustris/setacea* community (A23) forms the chief pteridological representation in this volume. *I. echinospora* is unfortunately called *I. setacea* throughout.

While it is easy to criticise the shortcomings of this ambitious series the authors are to be congratulated on so attractively and lucidly presenting us with the basis upon which a comprehensive descriptive account of British vegetation can be built. My main worry is that against the authors stated intention that this be considered "a first approximation" there seems to be little development from the work, perhaps through lack of a suitable journal venue? With the NVC incomplete but cast in tablets of stone, much is now being shoe-horned into inappropriate categories by people who must deal in an NVC category irrespective of its applicability.

The arrival of the eminently affordable paperback version means that now there is no excuse for anyone with an interest in British vegetation not to have a copy of this informative volume.

LOST FERNERY OF DARLASTON HALL

Lawrence Kirkham, 6 Queens Row, Longton Road, Barlaston, Stoke-on-Trent ST19 9AJ.

Just outside Stone in Staffordshire is a place called Darlaston; blink and you might miss it as you drive up the A34. It was near to here that I moved in 1997 to become the Headgardener at nearby Barlaston Hall. Some six months later whilst I was laid up in bed my wife brought me a treat, the local library had obtained a copy of volume 1 of *Our Native Ferns* by E. J. Lowe. In it I found no less than eighteen references to Swynfen Jervis of Darlaston Hall relating to his supply of fronds for illustrations. One of these is his own local find *Lastrea filix-mas' Jervisii'*, a crested MaleFern, he is also credited with holding the only *Polystichum angulare* 'Grandiceps Wollaston' in existence at the time (see cover). The book was published in 1862 at which point it would seem Darlaston Hall housed a fine collection of fern varieties particularly *Polystichum angulare*, known today as *Polystichum setiferum*. In Volume two of *Our Native Ferns* published in 1867 there are 18 further references to him as a contributor. There are particular items of interest, especially of the lady fern cultivars 'Polyclados-Dissectum' found in nearby Trentharn Park (a ramose cultivar), and two named cultivars 'Plumosum Jervisii' and 'variabile Jervisii'. I decided to look for the hall and its fernery.

The Hall had been in the possession of the Jervis family since the seventeenth century and the family name had changed over the years. Tracking down which member of the family was the Swynfen Jervis of Lowe's book was not as easy as it at first seemed. After much investigation I discovered the Swynfen Jervis of E. J. Lowe was in fact Swynfen Steven Jervis of the wealthy local family descended from Admiral Lord St Vincent. Swynfen Jervis is a character swathed in mystery and very little is known about his life. He was by all acounts an eccentric anti-cleric, who died in 1869 not long after E. J. Lowe published the book to which he contributed.

At this point in my investigation I discovered that the Hall had been demolished in the 1950's . Undeterred and after much detective work I set out with fellow society member Jim Bowyer one afternoon to find the site of the Hall. It is hard to describe how excited we became when the owner of the land told us that the fernery had survived and even had ferns in it! The fernery was situated in a deep hollow dug out of the side of the wooded hill, which was now

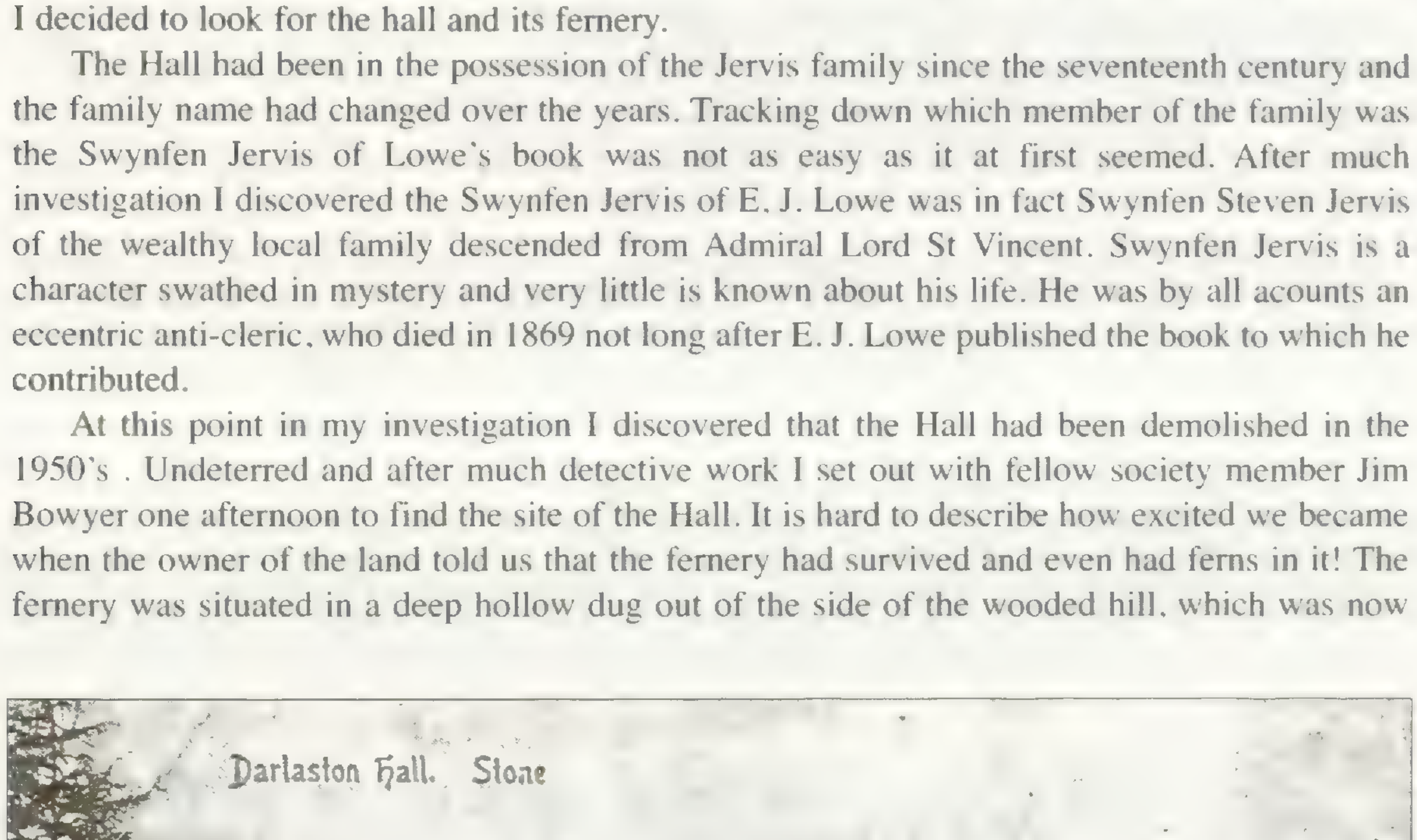

Fig. 1. Darlaston Hall, Stone. William Jervis of Meadford bought the Darlston Estate in 1655 from James Collier, a wealthy wool stapler. It remained in the possession of the Jervis family until 1880 when it was sold to the pottery manufacturer James Meakin. The Hall is now demolished.

Fig. 184.—Apex.

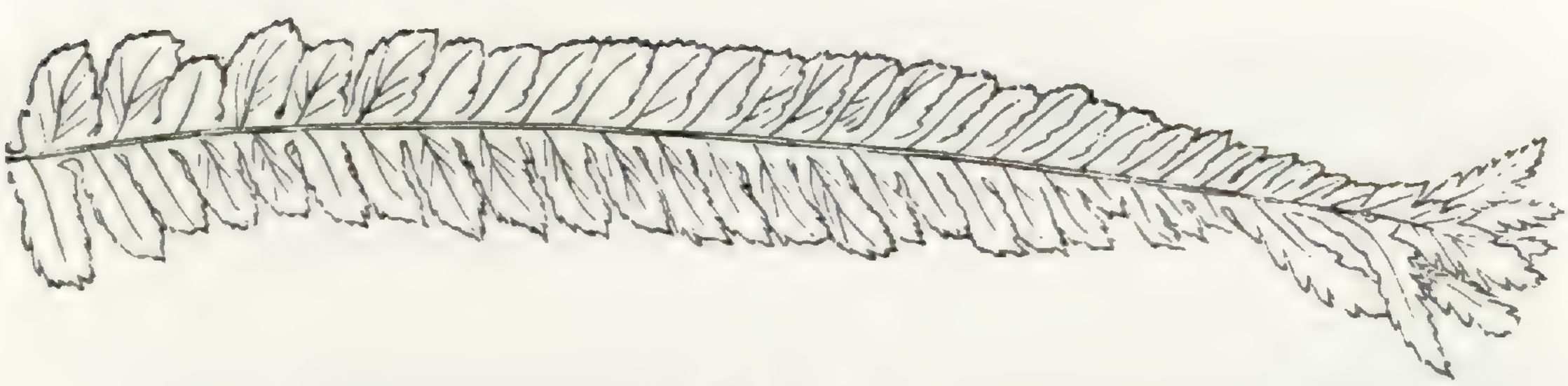

Fig. 185.

Fig.2. *Dryopteris filix-mas Jervisii* ' as illustrated in E.J. Lowe's 1st volume of *Our Native Ferns*.

heavily overgrown by nettles, brambles and self-sown sycamore. After scrambling through the undergrowth it was suddenly revealed to us, as we walked through the entrance I felt like I was entering a tomb filled with treaure. The hollow was almost like an ampitheatre, we were surrounded by large bolder-like rocks 1 to 1. 5 metres in size approx. These are said to of been supplied by the Quarry at Beech near Trentham. They were positioned with planter pockets for ferns and contained many old remains of ferns long dead. The ones remaining were mainly large *Polystichum setiferum* (which is hard to find locally) and *Dryopteris* species. It was at this point that Jim spotted a very old *Athyrium filix-femina* 'Cristatum' which is perhaps the last survivor of the'Swynfen Jervis Collection'. We also found a second entrance which was rather too steep for ease of passage and almost seemed a rather pointless addition. The whole fernery viewed from above in a sketch I made could almost be the shape of a giant sporangium.The shape of the fernery and the dense shade have prevented me from obtaining a decent photograph, but I intend to return in the winter.

It gave both of us great pleasure to be the first fern enthusiast's to see this fernery for well over a century, and we are most grateful to Mr E.C. Straiton for access to his land and Mr Stanley Gerrard for information on the Swynfen Jervis family.

THE PRESERVATION OF CHOICE FERNS

Robert Sykes, Ormandy House, Crosthwaite, Kendal, Cumbria LA8 8BP

I am concerned that the National Collection system of the National Council for the Conservation of Plants and Gardens may be failing to preserve some fine ferns (and other plants too no doubt) and I suggest that the BPS should be considering what happens to members' collections when they move house, lose interest, can no longer cope or die.

If one has a worthwhile collection of some plant one can apply to the NCCPG for designation as a National Collection. There is then a vetting procedure and if the application is accepted it is duly designated and listed in the Council's literature. The collection remains the owner's property of course but in making the application the owner accepts certain obligations. He/she is expected to keep a list of the items in the collection with provenance, dates of accession etc.-, to allow people to look round, to provide propagating material, to research the chosen species and the development of cultivars, to label the plants, to ensure the succession and so on. Now all that is very desirable, but...

Some years ago I had a letter from the NCCPG asking if I would like to apply for my collection of Polystichums to be registered under the National Collections scheme. I was working rather hard in those days earning my living and I balked a bit at any extra tasks. But I do care about what happens to my plants, there is a sense of trust, we inherited them from our skilful and committed forebears, and I want them to go down to the next generation (our afterbears?). There was also a plug for National Collections at our AGM that year. So I agreed to do it.

It was not a very happy tale. I filled an initial application form which qualified me to fill a further application form- I was firmly cast in the role of suppliant. I had a visit from a chap who looked round my collection, and apparently reported that my ferns were not labelled (which is true), but declined to look at my voucher set of pressed fronds, which I keep for record purposes. The whole ethos of the discussion was that I was seeking some kind of accolade, which I could have if I presented my collection their way. They kept talking of the importance of my 'research'. It is not very productive to go over the whole two year saga - indeed I have not kept copies, so I can't. My prevailing recollection is of a lengthy obstacle course. I failed in fact to leap all the hurdles and in the end they refused my application, sent me some notes on labelling, and asked me to let them know how I progressed. I did not plan to progress. All I was doing was collecting Polystichums.

So all that is a bit negative, and I must be wary of sour grapes. I have no doubt that the NCCPG is filling an important role, and the National Collection system has stimulated a lot of useful work. I do not want to knock it. But I wonder if by setting their standards too high (though I have seen some abysmal National Collections), they are excluding a myriad of more modest collections, with the consequent possibility that valuable plants may be lost.

Should we as a Society do anything about it so far as it affects ferns? Many choice cultivars have been lost over the years, often I suspect because they passed into ignorant or uncaring hands. Could we for example keep our own register of collections? The only qualification could perhaps be an undertaking by the owners that they would take steps to ensure that worthwhile plants were preserved in safe hands when they were no longer able to look after them. I suggest that quality control to NCCPG standards - or indeed any other standard - is another issue. The preservation of the plants is the important point. If that is backed by good records and labelling, research into the horticultural history of the species and so on - that is a bonus, but it is not the prime issue. We need to foster a culture of conservation, and if in the process of preserving a few excellent plants we save masses of second rate plants - is that a problem?

What can individual members do to ensure our best plants pass into safe hands (short of establishing a BPS garden packed with choice plants meticulously labelled)? It is going to depend clearly on individual circumstances. In practice I suspect many of us as we get older invite some trusted and interested friends to take the plants that interest them into their collections, and deal with it informally that way. Failing that ... ?

As a solicitor I have been thinking about whether one can usefully cover it in a will. If one leaves a garden to someone, then, if nothing else is said, that person gets the plants in it and can do what he likes with them. It would be possible, in principle, to leave one's garden to somebody and give someone else the right to remove the plants. Such a provision could read:

I give my property known as Fernacre to my executors, and I direct:
a. that within one month of my death they should tell the Secretary of the British Pteridological Society [*or some trusted friend*] that I have died;
b. they should permit [*that friend or*] the persons appointed by the said Society to inspect my garden and (subject to any conditions my executors may reasonably impose) to remove any ferns from my collection. Subject to those directions my executors shall hold Fernacre in trust for ..... absolutely.

That clause would form part of a full will. It would need to be tailored to the rest of the will and your particular circumstances by your solicitor. If it you feel that it is a bit draconian and could lead to some ill-feeling, try:

THIS CODICIL dated 1999 is
made by me [*name and address*)
1 I amend my Will dated.....as follows:
2 Without imposing a binding trust I ask the beneficiary who receives my property know as Fernacre under my Will to consult with the Secretary for the time being of the British Pteridological Society [*or some named individual*], and to allow the removal of ferns from my collection. [*or if you want them to be more selective* ... of choice ferns from my collection, if the beneficiary is advised that that is desirable to procure their survival for posterity.]
2 In all other respects I confirm my said Will.

Signed by the Testator in our
presence and attested by us
in the presence of the Testator
and of each other

That could be written out and signed (in the presence of two witnesses, who should also sign), as a rider to an existing will. (What was that? You have not made a will? Forget about your ferns - get round to your solicitor at once!) It should be placed with the original or it might be overlooked. I think that it may be as far as most people would want to go. It is not fool proof, because it has no binding force. The recipient could ignore it or take a flame thrower to the lot. But what fern lover would give their garden to a beneficiary who was likely to do that?

I would be interested to know if anyone has any other thoughts, or can improve on my drafting.

THE FERNS OF THE BADEN-POWELL DESK

Jennifer M. Ide, 42 Crown Woods Way, Eltham, London, SE9 2NN

INTRODUCTION

October 14th 1899 saw the beginning of the siege of the small but strategic town of Mafeking in South Africa at the beginning of the so-called Boer War. Its long defence, under the leadership of Colonel Robert Baden-Powell captured the imaginations of the British nation and its Empire. "The romance of the siege gave Mafeking an exaggerated value in popular opinion" so that when, after 217 days, on the 17th May 1900, the town was relieved by troops under the command of Major Brigadier-General Mahon and Colonel Plumer, not only the nation but the entire British Empire erupted with jubilation. Spontaneous street celebrations and parties, bonfires and fireworks were held in every corner of the Empire and Baden-Powell's home at Hyde Park was besieged. London was brought to a standstill for three days. Probably only one other event in modern times has had any comparable effect - the death of Diana, Princess of Wales. The Times published a special edition devoted to accounts detailing the life and exploits of Baden-Powell and the celebrations in London, including the siege of his mother's home at St George's Street, Hyde Park. In many parts of the Empire, newspapers committed broad sheet spreads to similar effusive accounts of the celebrations held on the days immediately following news of the relief in the towns and villages of their country. Subsequently, Baden-Powell was showered with honours and gifts by individuals and communities across Britain and the Empire.

THE COMMISSION

Among the many gifts that Baden-Powell received was a beautiful inlaid desk from the people of the Province of Auckland New Zealand (fig.1). The desk was specially commissioned from William Seuffert, the son of Anton Seuffert, a Bohemian immigrant who had quickly established himself as a cabinet maker of rare talent on his arrival in New Zealand sometime in the 1850s. Anton had been commissioned to make several escritoires as presentation pieces, probably the earliest of which was one for Queen Victoria in thanks for sending troops to help in the Maori Land Wars of the mid-19th century. William had learned his craft from his father, but the Baden-Powell desk is the only known desk by him, and is his most significant piece. It took William two and half years to make and was displayed in the Auckland City Art Gallery before being shipped to England. Undated newspaper cuttings of the time (about 1903) are most enthusiastic about it. '... The escritoire is composed of a variety of New Zealand woods artistically inlaid and polished, and richly embellished with ornamentations representative of New Zealand life and scenery. The front of the main panel contains a well-executed scene of Auckland Harbour, with the lower portion of Ponsonby and part of Freeman's Bay in the foreground, the wharves and shipping well displayed in the centre, and Devonport, the North Head and the outline of several of the islands in the distance. The side panel[s] contain representations respectively of a Maori chief and a wahine [Maori woman] and her piccaninny, whilst the front of the drawers are inlaid with ferns, ti-tree, flowers, titoli and other leaves, acorns, etc. The escritoire is surmounted by a finely-wrought wreath of ferns and other native leaves, with the figure of a tattooed Maori's head in the centre. The desk contains a silver tablet bearing the following inscription: "Presented to Major-General R.S.S. Baden-Powell by admirers in the Province of Auckland, New Zealand, in recognition of distinguished services rendered to the Empire during the siege of Mafeking from October 13, 1899 to May 17, 1900." ' From another article in another paper, 'The Cabinet is a remarkably brilliant piece of workmanship, and is made of New Zealand woods cleverly inlaid to give colour and design to the article. ...'

THE DESK

The desk consists of a knee-hole desk with a set of four drawers on each side, and a superstructure in the style of a Louis XV escritoire, with a large central cupboard and a set of four small drawers each side of the cupboard, each enclosed by a door. There is a writing slide below the central cupboard. As described above, the whole is inlaid with pictorial scenes and representatives of the New Zealand flora, with ferns dominating. Motifs inspired by Maori art also occur. All are in such exquisite detail that it has been possible to identify the plants and the source of the pictorial scenes. Decorative carvings on the superstructure and in the knee-hole are also a feature of the desk, but these are not by William Seuffert but by Anton Teutenburg, a German immigrant to New Zealand and a medallist by trade, who was also responsible for the carvings on the presentation desks made by William's father.

Fig. 1 The Baden-Powell desk.

The doors of the superstructure

The picture on the outside of the central door of the superstructure is from a photograph of Auckland Harbour taken from Ponsonby in 1897. The scene has been described earlier but does not mention the small tree fern, most probably *Cyathea medullaris* (Forst. f.) Swartz (black tree fern or mamaku) which can be seen in the bottom left corner. A larger example can be seen on the panel of the left hand door of the superstructure (fig.2) which depicts a Maori woman carrying her baby and standing in front of a Meeting House. At the left, the *Cyathea medullaris* is recognisable by the typical arching habit of its leaves and the persistent dead fronds typical of young black tree ferns. With trunks up to 20m this is probably the most handsome and readily identifiable of New Zealand's tree ferns and certainly one of the most common. It would certainly have been known to William Seuffert. *Rhopalostylis sapida* Wendl. & Drude (nikau palm), New Zealand's only native palm, occupies a mirror position in the panel with the Maori warrior on the right hand door.

Fig. 2. Baden-Powell desk: the left-hand door. *Cyathea medullaris* at left.

But it is on opening the doors of the superstructure that the real delight is to be had. Set against a light, diagonal chequer-board patterned background are portions of fern leaves in darker coloured veneers. Because the panels would not have been exposed to light for any significant lengths of time the colours of the veneers are as crisp as the day they were inlaid nearly one hundred years ago. The immediate impact of the clever use of contrasting woods and the accuracy of the leaves caused me to squeal in amazement and delight as I explored the desk on the occasion I discovered it! Although at the time I knew nothing of New Zealand ferns, it was obvious that the inlays were so accurate that it should be possible to identify the ferns concerned.

Fig. 3. Inside panel of centre door.

On the inside of the central door is a group of three fronds (fig.3). To the left of the central, and very distinctive fertile frond of *Blechnum discolor* (Forst.f.) Keyserl. (crown fern or piupiu), is part of the lower pinna of *Histiopteris incisa* (Thunb.) J.Smith (water fern or matata). On the right is the lamina of *Pteris macilenta* A.Rich. (sweet fern). A pinna from the middle of a frond of *Loxsoma cunninghamii* Cunn. adorns the inside panel of the left hand door (fig.4). Confined to North Island, this once common, handsome, low growing New Zealand endemic of damp open forests and clearings, is now relatively scarce, much of its former habitat having been lost due to land development. On the inside panel of the right hand door is a leaf of *Adiantum cunninghamii* Hook. (common maidenhair or Puhinui) (fig.5). Common throughout North and South Island, particularly in coastal and lowland forest, this is New Zealand's most common maidenhair.

Fig. 4. Inside panel of left-hand door with *Loxsoma cunninghamii*.

Fig. 5. Inside panel of right-hand door with *Adiantum cunninghamii*.

Fig. 6. A set of drawers from the knee-hole desk

The drawers of the knee-hole desk

The two identical sets of four drawers (fig.6), one each side of the knee-hole, are inlaid with representative flora of the New Zealand bush, but it is the top two pairs of drawers which are of interest to pteridologists for the inlay is of portions of fern leaves. Unfortunately the portions are small and it is difficult to be certain of any identification, but a comparison with many herbarium specimens enables an educated guess to be made on their probable identities.

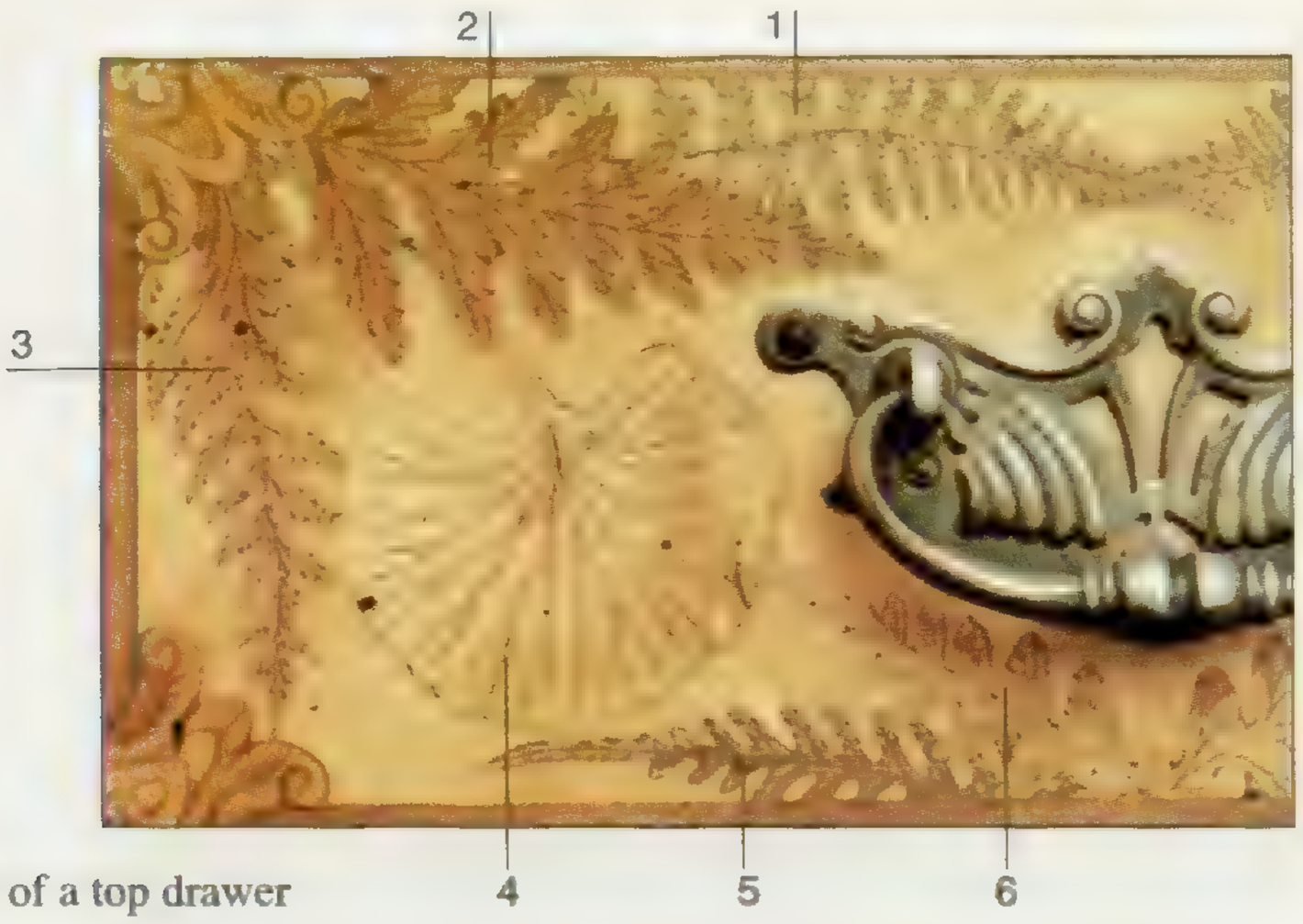

Fig. 7 A detail of a top drawer

Top pair of drawers (fig.7 detail):

1. Of the seven New Zealand species of *Hypolepis* Bernh., a comparison of herbarium specimens suggests three species as likely candidates for this segment, but *Hypolepis ambigua* (A.Rich.) Brownsey & Chinnock being the most common must be first choice.

2. There is some similarity of this frond portion with the tip of *Histiopteris incisa* (see inside panel of central door of the superstructure) but comparison with herbarium specimens suggests this is probably the tip of the frond of *Asplenium lamprophyllum* Carse.

3. This is most likely the tip of a pinna of *Loxsoma cunninghamii* Cunn. Another possible but less likely candidate is a pinna tip of *Diplazium australe* (R.Br.) Wakef.

4. Without a doubt this is a frond of the very attractive filmy fern, *Trichomanes reniforme* Forst.f. (kidney fern or Raurenga). It is an unforgettable experience to see the sun shining through the leaves of this fern which occurs, amongst other places, in small carpets in the shade of trees on the volcanic island of Rangitoto, in the Hauraki Gulf.

5. Tip of a frond of *Doodia media* R.Br. (prickly rasp fern or pukupuku).

6. Pinnule tip of *Histiopteris incisa* (Thunb.) J.Smith.

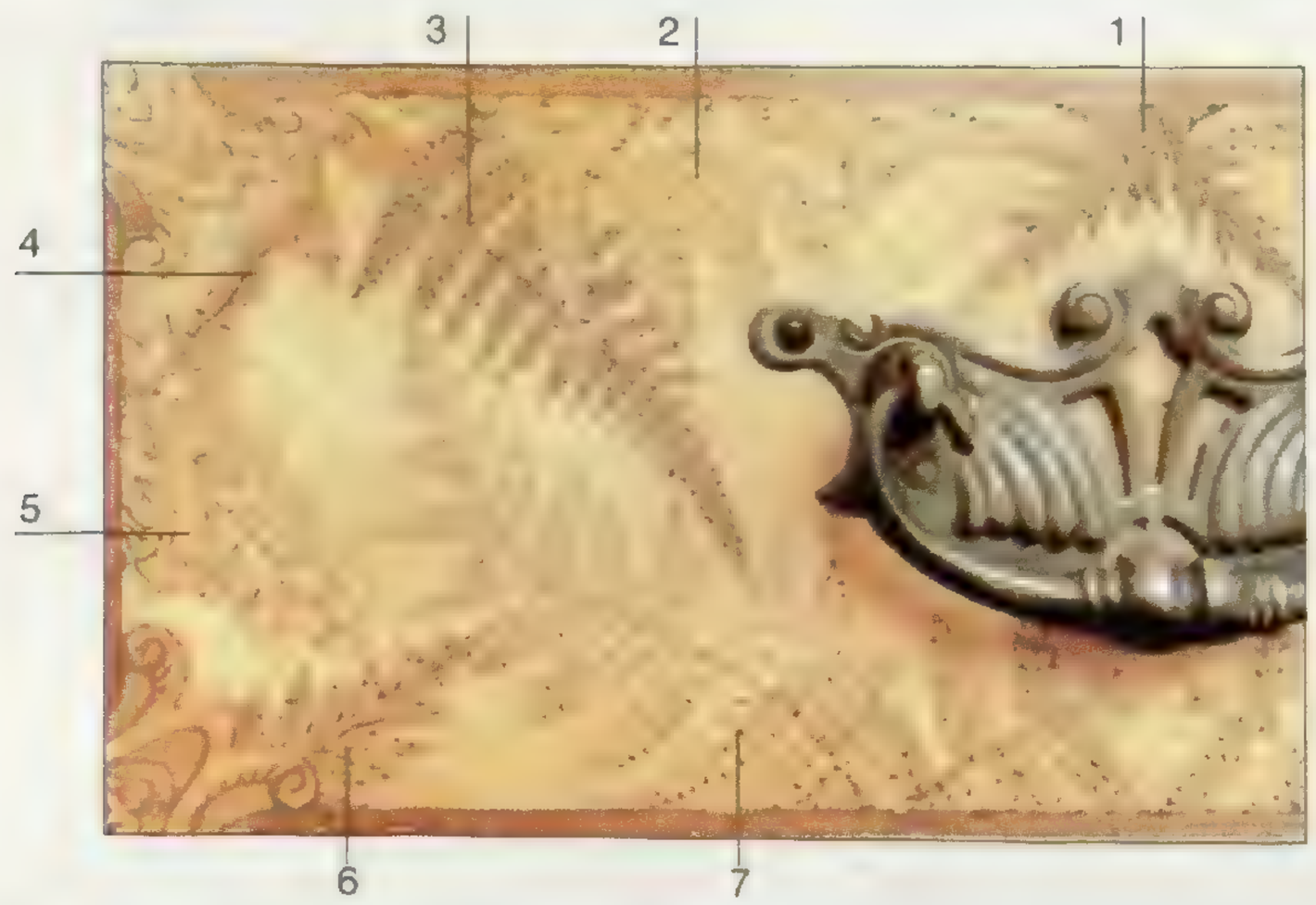

Fig. 8 A detail of a second drawer.

Second pair of drawers (fig.8 detail):

1, 2, 4, 6. These are portions of the spleenwort, *Asplenium lamprophyllum* Carse.

3. Portion of a pinna of *Dicksonia squarrosa* (Forst.f.) Swartz (rough tree fern or wheki), another of New Zealand's more common tree ferns. The dark spots seen in the angles of the toothed margins of the segments could be interpreted as the marginal sori found in *Dicksonia* species and frequently seen from the upper surface of the leaf. However, it is more likely that they result from the turning of the cutting blade when the inlay was prepared, and the subsequent filling in of the space by lamp black when the venation was demarcated, rather than exceptional observation by the cabinet maker!

5. A pinna portion of the *Adiantum aethiopicum* L. (true maidenhair). The veining of the leaf segments is at odds with that of other leaves in that there is an apparent carelessness in the way they have been drawn. In most of the other fronds, although not accurate, the veining does bear some resemblance to that of the relevant ferns and does not have a slap-dash quality about it.
7. These are most curious leaves and do not look at all natural. They cannot be identified with any plant and may merely be a figment of William Seuffert's imagination. Their tips and the arrangement of the sub-divisions of the leaves are particularly unfern-like; neither are they acceptable for a pinnately compound angiosperm leaf. Also, a curious forking of the leaves can be seen under the handles of the drawers. It is possible that these leaves are fern inspired and if this is so, then a tree fern is possibly the most likely candidate. Or perhaps a frond of a *Hypolepis* Bernh. species was the template but, having lost the tip, Seuffert drew one in, albeit an inaccurate one! These leaves are an enigma! When all the other plants on the desk are portrayed with such accuracy why should William be so careless with these, and also with the veining of the *Adiantum*? Various suggestions come to mind but none are particularly plausible.

Third and fourth pairs of drawers (see fig.6):
In contrast to the upper two pairs of drawers, the inlays of the third and fourth pairs are mainly representative of angiosperm trees or shrubs. Also, the designs are asymmetrical. On the third pair of drawers are to be seen flowering sprays of *Hoheria populnea* A.Cunn. (lace bark or Houhere), a spray each of *Aristotelia serrata* (J.R. & G.Forst) W.R.B.Oliver (wineberry or Makomako), *Leptospernum scoparium* Forster & Forster f.(tea-tree or manuka), and *Fuchsia excorticata* (J.R. & G.Forst) Linn.f. A spray of *Leptospernum scoparium* also features on the fourth pair of drawers, together with sprays of the fruits of *Alectron excelsus* Gaertn. (titoki), and of *Corynocarpus laevigatus* J.R. & G.Forst. (New Zealand laurel or Karaka), and *Dodonaea viscosa* Jacquin (akeake). There is also a reprise of two ferns seen on the second pair of drawers, a frond tip of the spleenwort, *Asplenium lamprophyllum* and a portion of a pinna of *Dicksonia squarrosa* (Forst.f.) Swartz.

The making of the inlays
There is no surviving information about the way in which the Seufferts prepared their fern inlays. Undoubtedly they were fine draftsmen, William in particular, but the ferns on the desk are so accurate, in outline at least, even if in most cases a little artist's licence has been taken with the venation, and all are within the normal life size range for the ferns concerned, that pressed fern fronds were probably used as templates. Two other features, observable in some leaves, support this hypothesis. These are features resulting from 'nurture rather than nature', such as the hooked pinnae near the tip of the fertile frond of *Blechnum discolor* on the central door; and particularly in those ferns with thinnish laminas, the outline of the ultimate segments are sometimes more characteristic of pressed fronds than living ones, their shape resulting from a slight inrolling of the margins. This latter feature commonly occurs when thin leaves are pressed with insufficient care.

The carvings
Now lost, there was originally a magnificent carving surmounting the central part of the superstructure of "... a finely wrought wreath of ferns and other native leaves, with the figure of a tattooed Maori's head in the centre". However, the fan-shaped grouping of leaves, each side, near the top of the taller central cupboard of the superstructure, are still present (fig.9). Teutenberg has carved:

1. a pinna of a shield fern (*Polystichum* Roth sp., possibly *P. vestitum* (Forst.f.) C.Presl (prickly shield fern or Puniu), the most common *Polystichum* species in New Zealand),
2. a possible frond of *Tmesipteris lanceolata* (fork fern),
3. two fronds of *Pellaea rotundifolia* (Forst.f.) Hook. (button fern or tarawera),
4. two fronds of *Anarthropteris lanceolata* (Hook.f.) Pichi Serm. (lance fern), suggested by the sunken midrib which is very evident in this genus, although another possibility is the leaf of a flowering plant,

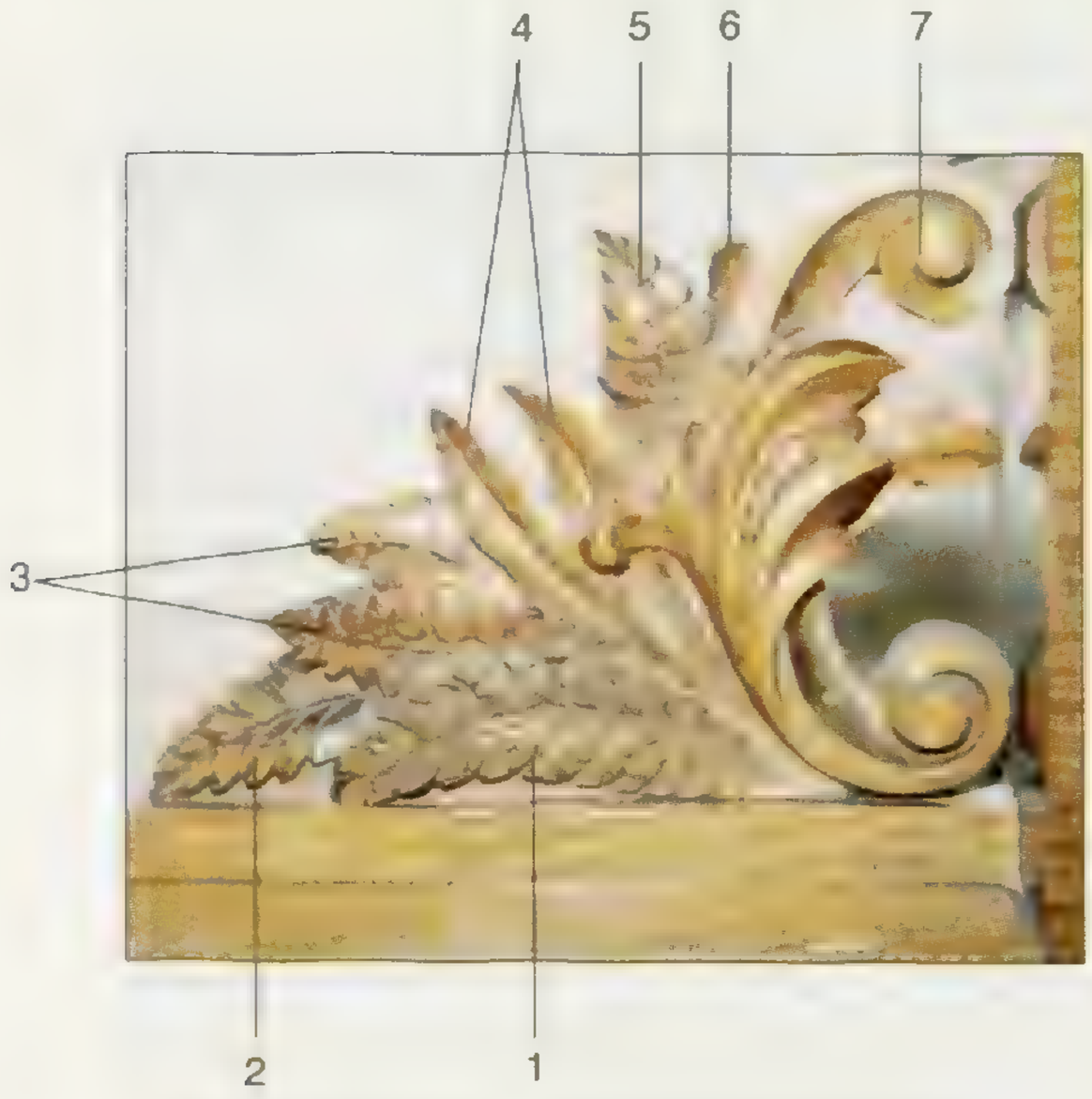

Fig. 9 Carving on the superstructure.

Fig. 10 Carving in the knee-hole.

5. a compound leaf of an unidentified flowering plant, (*Sophora* L. has been suggested but the pointed tips of the leaflets are not typical of those of *Sophora* species), and
6. another possible frond of the lance fern.
7. The spray of leaves is elegantly braced to the side of the central cupboard by a curved bracket ending in two coils, which can be interpreted as stylised fern croziers, from which issues a small spray reminiscent of *Acanthus* L. leaves.

In the angles at the top of the knee-hole are carvings which echo the corner carvings of the superstructure (fig.10). Each has:

1. an *Acanthus* leaf spray with scrolls,
2. two fronds of *Pellaea rotundifolia*,
3. two possible stems of *Tmesipteris lanceolata*.

All the ferns seen on the desk would have been common in the environs of Auckland at the time the desk was made, though several of them are relatively scarce now, possibly even extinct in the area. Although not very practical as a desk, and some might say not a particularly attractive piece of furniture, the Baden-Powell desk is a pteridophyles delight. After her husband's death, Lady Olave Baden-Powell kept her treasures in it. What a treasure chest!

ACKNOWLEDGEMENTS

I would like to thank the present Lord Baden-Powell for permission to research the desk, Joy Bilkey for information about Anton and William Seuffert and the newspaper cuttings, Peter Edwards of the Royal Botanic Gardens, Kew and Kerry Ford (NZ visitor to RBG) for initial help with the plant identification.

SELAGINELLA P.BEAUV. IN CULTIVATION.

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I first came accross *Selaginella* in the wild on Reunion Island where they seemed so small, elegant and neat. Nobody there could give them a name and they are often a neglected and overlooked genus, both in the wild and in cultivation.

Selaginella is usually given as the only genus of living plants in the family *Selaginella*ceae. There are over 750 species of *Selaginella* distributed around the world, with exception of the Arctic and Antarctic.

The division Lycophyta contains three orders of living plants all with microphylls and reproducing by spores:

Lycopodiales: c.120 species, homosporous and small-leaved. Some have strobili, others more archaically have fertile regions within the leafy shoot. This order also contains the highly specialised *Phylloglossum*, which is known only from a few sites in New Zealand and Australia.

Selaginellales: c.750 species, heterosporous and small-leaved. All have strobili which are more obvious in some than others.

Isoetales: c.80 species, heterosporous with large linear leaves. The large sporangia are sunk into the basal portions of the leaves.

Within the genus *Selaginella*, two major groups can be recognised on morphological characters. Isophyllous species (leaves are all the same size as in *Lycopodium*), and anisophyllous species (the lateral leaves and axillary leaves are of different sizes). The structure of the strobilus is useful to define the groupings further. The sporophylls are called microsporophylls, if they have 'male' (microsporangia) or megasporophylls if they have 'female' (megasporangia) sporangia in their axils. The strobili can be isophyllous or anisophyllous. *Selaginella* has been subdivided many times on the basis of leaf characters, cone characters and growth habit. The adventitous (arising directly from the aerial parts of the stem) root-like rhizophores that branch dichotomously, are also useful for identification.

Selaginella has perhaps a greater diversity of habit and pigmentation within the range of its species than any other fern or fern ally genus. Let me try to show you.

Selaginella does have some very interesting gowth habits apart from the often seen creeping ones like *S. kraussiana*, *S. martensii* and *S. denticulata*. There are:

- Annuals, of which there are four: *S. tenerrima*, *S. tuberosa*, *S. pygmaea* and *S. gracillima*.
- Rosette-forming species with short rhizomes and short inter-nodes, e.g. *S. pallescens*, *S. lepidophylla* and *S. tamariscina*.
- Upright rhizomes which bud out from the base of the plant once the strobili are produced, e.g. *S. delicatula*, *S. gigantea*, to 4 metres tall.
- Semi-climbers, perhaps better called a rambling habit, where by the rhizophores formed are quite tough and are able to hook the plant into other vegetation, e.g. *S. willdenovii*.
- Short erect tufted species, looking more like robust giant mosses (homophyllous/isophyllous species) e.g. *S. selaginoides*, our only British native species.
- Creeping rhizomes with erect secondary or tertiary branches forming parasoles e.g. *S. vogelii*, *S. haematodes* and *S. erythropus*.

Many different pigments are displayed by *Selaginella* which are already cultivated:

- Blue: irridescence: *S. uncinata*, *S. willdenovii*, and to a lesser extent *S. vogelii* and *S. lyallii*.
- Red: *S. erythropus* (a form from Colombia)
- Variegated: *S. martensii* forma 'albovariegata', *S. martensii* var. 'watsoniana' (considered under forma 'albovariegata', but different variegation patterns exist), and *S. martensii* var. 'variegata'. *S.* tamariscina in cultivation in Japan (called Iwahiba is another story altogether). There are over 250 known forms and varieties of Iwahiba, with different colour forms and habits, many variegated, and often changing colour with the seasons.
- Golden: *S. kraussiana* var. 'aurea', pretty hard to beat for it's yellow mat forming habit and tolerance.
- Silver: *S. viticulosa*, is light green on top but a healthy plant is very silvery underneath.

The temperature and light tolerances are quite varied vetween the species of course reflecting the conditions in which they naturally occur. Here is a list of all the *Selaginella* known to be in cultivation so far by the author, any contributions to this would be welcomed. Abbreviations used here: (UK) = cultivated in the United Kingdom; (USA) = cultivated in the United States of America; (Eur) = cultivated in Europe; * = suitable to a cool glasshouse (min. 5 degrees C); ** = fully hardy in London (try it and see). # = tolerates sun for periods.

1. *Selaginella anceps* (Presl) Presl Distribution - Luzon, Philippines. (USA)
2. **S. *apoda* (Linn.) Fern. Distribution - N.America. (UK) (Eur)
3. *S. *biformis* A.Br. ex Kuhn. Distribution - Asia. (UK) (Eur)
4. *S. *braunii* Baker. Distribution - Asia. (UK) (USA) (Eur)
5. *S.* x *burgefii* (*pilifera* x *pallescens*) sensu A.B.Graf. "Exotica International Pictorial Cyclopeadia of Exotic Plants", series 4 vol. 2, pp. 2061 & 2348, Distribution - Garden origin. (UK) (Eur)
6. *S. cesatii* Hieron. Distribution - Sarawak, Borneo. (UK)
7. *S. delicatula* (Desv.) Alston. Distribution - India and S.E. Asia. (UK) (Eur)
8. **S. *denticulata* (Linn.) Spring. Distribution - Europe and N.Africa. (UK) (Eur)
9. *S. diffusa* (Presl) Spring. Distribution - S.America. (UK) (Eur)
10. *S. dregei* (Presl) Hieron. Distribution - East Africa. (Eur)
11. *S. echinata* Baker. Distribution - Africa. (Eur)
12. *S. elmeri* Hieron. Distribution - Philippines.(UK)
13. *S. erythropus* (Mart.) Spring. Distribution - S.America. (UK) (Eur)
14. *S. erythropus* (Mart.) Spring. (Red form) Distribution - originally grown in Cali, Colombia. (UK) (Eur)
15. *S. eurynota* A. Br. Distribution Cental America. (USA)
16. #*S. *fissidentoides* Hook. & Grev. Distribution - Madagascar. (UK)
17. *S. flabellata* (Linn.) Spring. Distribution - Central America. (USA) (Eur)
18. # *S. goudotiana* Spring. Distribution - Africa (Eur)
19. # *S. grandis* Moore. Distribution - Borneo.(UK) (Eur)
20. *S. haematodes* (Kunze) Spring. Distribution - Panama and South to Bolivia. (UK)
21. #**S. *helvetica* (Linn.) Spring. Distribution - Europe, Asia Minor.(UK) (Eur)
22. *S. heterodonta* (Desv.) Hieron. Distribution - Jamaica (UK) (Eur)
23. *S. hoffmannii* Hieron Hieron. Distribution - Mexico south to northern S. America. (USA)
24. *S. inequalifolia* (Hook. & Grev.) Spring. Distribution - India and Burma (USA)
25. #*S. *integerrima* (Hook.& Grev.) Spring. Distribution - Mascarenes (UK) (Eur)
26. *S. involvens* (Sw.) Spring. Distribution - Asia. (UK) (Eur)
27. *S. jagori* Warb. Distribution - Luzon. (UK)
28. #**S. *kraussiana* (Kunze) A.Br. Distribution - S.Africa.(UK) (USA) (Eur)
29. #**S. *kraussiana* var. aurea W.Bull Distribution - Garden origin from Kenton Hall, Scotland. (UK) (Eur)
30. #**S. *kraussiana* var. brownii Hort. Distribution - Azores. (UK) (USA) (Eur)
31. #**S. *kraussiana* var. poulteri (Veitch) A.Br. Distribution - Azores. (UK) (Eur)
32. #**S. *kraussiana* var. variegata Hort. Distribution - Garden origin. (UK) (USA) (Eur)
33. # *S. lepidophylla* (Hook. & Grev.) Spring. Distribution - N. and Central America. (UK) (USA) (Eur)
34. S. lobbii Veitch ex A. Br. Distribution - Borneo. (USA)
35. S. ludoviciana (A.Br.). Distribution - N. Florida, Louisiana and Texas. (USA)
36. *S. lyallii* (Hook. & Grev.) Spring Distribution - Madagascar. (UK) (Eur)
37. #*S. *martensii* Spring Distribution - S.America. (UK) (USA) (Eur)
38. #*S. *martensii* forma albolineata (Moore) Alston. Distribution - Garden origin. (UK) (Eur)
39. #*S. *martensii* forma albovariegata (Bull) Alston. Distribution - Garden origin. (UK) (USA) (Eur)
40. #*S. *martensii* var. divaricata A.Br. Distribution - Mexico. (UK)
41. #*S. *martensii* var. watsoniana Hort. Distribution - Mexico. (UK) (Eur)
42. *S. microdendron* Baker. Distribution - Jamaica. (UK) (Eur)
43. *S. microphylla* (HBK) Spring. Distribution - Colombia. (UK) (Eur)

44. *S. mnioides* (Sieber) Spring. Distribution - Venezuela. (UK) (Eur)
45. *S. moellendorfii* Hieron. Distribution - E. and S.E.Asia. (USA)
46. *S. mollis* A.Br. Distribution - Central America. (USA)
47. *S. muscosa* Spring. Distribution - Brazil. (UK) (Eur)
48. *S. nipponica* Franch. & Sav. Distribution - China to Japan. (USA)
49. #**S. njamnjamensis* Hieron. Distribution - Nigeria, Sudan, Dahomey, Cameroun. (UK) (Eur)
50. *S. oaxacana* Spring. Distribution - Central America. (UK) (Eur)
51. #**S. obtusa* (Beauv.) Spring. Distribution - Mascarenes. (UK) (Eur)
52. #***S. oregana* D.C.Eaton. Distribution -Oregon. (UK)
53. *S. pallescens* (Presl) Spring. Distribution - Mexico (UK) (USA) (Eur)
54. #*S. pallescens* forma aurea (Hill) Alston. Distribution - Garden origin. (UK) (Eur)
55. *S. patula* (Sw.) Spring. Distribution - West Indies. (Eur)
56. ***S. peruviana* (Milde) Hieron. Distribution - Peru to Oklahoma. (UK) (Eur)
57. #*S. pilifera* A.Br. Distribution - Texas to Mexico.(UK) (Eur)
58. *S. plana* (Desv.) Hieron. Distribution - Asia. (UK) (Eur)
59. *S. plumosa* (Linn.) Presl. Distribution - West Indies. (Eur) (USA)
60. *S. popayanensis* Hieron. Distribution - Northern S. America. (USA)
61. #*S. pulcherrima* Liebm. Distribution - Mexico. (UK) (Eur)
62. #*S. rodriguesana* Baker. Distribution - Rodrigues. (UK) (Eur)
63. *S. rotundifolia* Spring. Distribution - Antilles. (Eur)
64. #***S. rupestris* (L.) Spring. Distribution - N.America. (UK)
65. #***S. sanguinolenta* (Linn.) Spring. Distribution - Asia. (UK) (Eur)
66. *S. serpens* (Desv.) Spring. Distribution - West Indies. (UK) (Eur)
67. #***S. sinensis* (Desv.) Spring. Distribution - Manchuria, China. (UK)
68. *S. speciosa* A.Br. Distribution - Colombia. (UK) (Eur)
69. *S. stauntoniana* Spring. Distribution - Mongolia, China, North and South Korea. (USA)
70. *S. stenophylla* A.Br. Distribution - Mexico. (UK) (Eur)
71. #***S. tamariscina* (Beauv.) Spring. Distribution - Asia. (UK) (USA) (Eur) There are 250. or more, cultivars and varieties grown in Japan.
72. #***S. tamariscina* var. pulvinata (Hook. & Grev.) Alston. Distribution - Tibet, China, Assam. (UK)
73. *S. umbrosa* (Lemaire) Hort. Distribution - S. America. (UK) (Eur)
74. #**S. uncinata* (Desv.) Spring. Distribution - Asia. (UK) (USA) (Eur)
75. *S. versicolor* Spring. Distribution - Asia. (UK)
76. *S. victoriae* Klotzsch. Distribution - Asia. (UK)
77. #**S. viticulosa* Klotzsch. Distribution - S. America. (UK) (Eur)
78. *S. velutina* Cesati. Distribution - Asia. (UK)
79. *S. vogelii* Spring. Distribution - Africa. (UK) (Eur)
80. *S. wallichii* (Hook. & Grev.) Spring. Distribution - Asia. (UK) (Eur)
81. #**S. wightii* var. phillipsiana Hieron. Distribution - Kenya, Somalia, Uganda, Tnzania. (UK) (Eur)
82. #*S. willdenovii* (Desv.) Baker. Distribution - S.E.Asia. (UK) (USA) (Eur)
83. *S. xiphophylla* Baker. Distribution - Peru. (USA)

If any readers know of other species in cultivation, true to name or as yet without a name, please do contact me.

CULTIVATION TECHNIQUES

Contrary to belief, selaginellas are quite undemanding if at least the following two criteria are followed; Firstly, relatively high and constant humidity, above 80%, is recommendable and secondly the temperature needs to be sufficiently high for most tropical species. The temperature regimes in the previous section of this article should be a good conservative, but tested, guideline to the temperature tolerances of *Selaginella*. If the humidity is kept high enough then it will not be too detrimental if the temperature drops or rises a little (however the tropical species will not thrive below eight degrees Celsius and near to 100% relative humidity in winter).

Temperature and lighting.
Periods of low temperature for the tropical species in general can be endured for up to a couple of weeks, after which rotting can occur. This has been tested with a break down in the heating system at the Barbican. All species survived at about 7-8 degrees Celsius for 3 weeks although partial rotting occurred on some species and resultant growth from February onwards was very poor and slow. Full sun can only be tolerated by some species, in general the variegated and golden forms do best with more sunlight, but direct and constant sunlight does not give the best results for aesthetics. It often scorches the plant after only a few minutes, causing shriveling or death. To acclimatise therm, plants should be placed into a lighter spot slowly over weeks.

Most selaginellas are terrestrials in forests and so are best grown on north or north-east facing situations. Dappled shade is fine, but beware of scorching because strong light can cause fluctuations in relative humidity. Positioning nder a glasshouse bench or in the shade of other plants is ideal for *Selaginella*.
Containerized plants.
Traditionally plants requiring high relative humidity were grown under glass bell jars otherwise known as cloches. Wardian cases were used at the end of the 19th century and the beginning of the 20th century. Recently terrariums have been used to grow humidity demanding plants easily. Central heating (or heating in glasshouses) lowers the humidity too low for many plants which is easy to remedy in a glasshouse but none the less labour and water demanding. So why not grow plants in their own environment within your home, garden or glasshouse?
Using glass or plastic bell jars or propagation cases seems the easiest way to keep demanding plants happy with little work!

The entire National Collection of Selaginella is kept in plastic bottles (the accompanying diagram shows you how). This can be done with any two bottles of the same size from 0.5 litres (soft drinks) up to 19.2 litres (office drinking water dispensers). The thicker the plastic the harder it is to cut and also less light will reach the plant. Clear plastic is best although mineral water bottles with a blue tint will also allow enough light for growth. The two bottle container inverted into each other needs airing for a few minutes every two or three weeks, to empty out condensation and to balance up the gaseous content of the container.

Watering need only be carried out when the compost begins to dry, which can be assessed by eye or measured by weight loss. I have found that I have only needed to water plants 5 or 6 times a year, adding a light organic liquid fertilizer every other watering. Pots must be watered outside of their plastic bottles and allowed to drain first. Using the plastic bottles is cheap, practical, can be a little unsightly, but labour saving and practical. The restriction of plants to these containers does limit height and spread, but above all it keeps pests out (if in a glasshouse) and stops plants from growing into each other. Plants in plastic bottle containers must also be kept out of sunlight as they can over heat and then cause the plants within to rot.

In a glasshouse, pots of similar species grown near each other have the tendency to root into each other, leaving two or more plant sin one pot with only one label! This has been one of the major reasons for many selaginellas in cultivation having the wrong names attached to them.

I have found that two 5 litre bottles are sufficiently large for most selaginellas, other ferns also grow well in these conditions, for example, young *Marattia*, *Angiopteris*, *Lecanopteris* and *Huperzia*.
Potting and Propagation.
Terracotta or plastic pots are suitable, although plastic pots are best in plastic bottle containers or propagators because terracotta quickly become slimy with algae growth.

Plants can grow very rapidly during summer in a good position. Winter growth can be also quite significant, even under our low winter light levels. Potting can be done anytime between the end of January and the beginning of October without detriment to the plant. Rapid growing plants usually means lots of cuttings to start of the stock in a suitable sized pot again. For some species such as *S. diffusa*, *S. stenophylla*, *S. kraussiana* and *S. uncinata* repotting has to be done up to three times a year.

Propagation is best done either by division of a clump or potted plant or by taking tip cuttings (2cm+) from any part of the plant that bears or produces rhizophores. Propagation is best done from February to April, they start new growth early, just as last years growth begins

to die back. Selaginellas with an upright habit usually cone during the winter and once the cones have been produced the whole upright coning branch will begin to die back a few weeks later. During this time, usually late winter, new growth will emerge from the prostrate primary stem or rhizome.

Composts.

Selaginella is tolerant of most soil types, with exception of heavy clay. Most selaginellas tolerate a neutral compost, with a few exceptions such as *S. helvetica* which requires a lower pH of about 5.5. In a glasshouse coir, peat, fine pine bark, and sand, loam and charcoal (which helps absorb toxins and can help inhibit soil pathogens) in lower quantities can all be included in the potting mix. I have found good results with just pure coir, or 2/3 coir 1/3 fine bark. *Selaginella* grown in the open glasshouse will require much more watering, often daily if a loose potting mix is chosen.

Pests.

In the garden and glasshouse selaginellas can suffer from slug and snail attack, though out in the garden, most species can become quite toughened to snail damage. The other pest I have seen on my collection is scale insect on *S. vogelii* which is awkward to remove. Selaginellas do not like to be sprayed with any pesticides, even organic remedies such as nicotine, which might also spread tobacco mosaic virus. They have very thin cuticles and can shrivel quickly in response. A fungus called *Uredo vetus*, a rust from China, has been discovered on *Selaginella* spp. in the wild (Hennen 1997), but is not known in collections.

In the Garden.

Outside in the garden, the best position are either in Terracotta pots plunged in sand or bark to maintain humidity or planted in a rockery. They can become swamped out by weeds germinating within them, which should be pulled out with tweezers. An ideal plant for the alpine enthusiast is *S. kraussiana* can be planted in a small area as a lawn substitute although it will not tolerate frequent trampling. It can also set spore and become invasive. I know of no other *Selaginella* which can set spore, reproducing sexually (ex-vitro) in cultivation.

Availability.

To find out which species are available please consult the most up to date R.H.S Plantfinder. The most commonly sold selaginellas are *S. martensii* (forms and varieties) and *S. kraussiana* (varieties). The specialist nurseries in the plantfinder do offer a wider range of species.

MAJOR SELAGINELLA COLLECTIONS IN EUROPE

A list of European Institutions and Botanic Gardens with the main collections of *Selaginella*:

U.K. National Collection of *Selaginella*; Barbican Centre, London, U.K. - 75 taxa.
Conservatoire et Jardins Botanique de Nancy; Nancy, France - 62 taxa.
Royal Botanic Gardens, Kew, London, U.K. - c. 55 taxa.
Botanischer Garten Bayreuth, Germany - c. 35 taxa.
Botanischer Garten Munchen-Nymphenburg, Munich, Germany - 29 taxa.
Jardin Botanique de la Ville de Lyon, France - 23 taxa.
Botanischer Garten Heidelberg, Germany - 23 taxa.
Jardin Botanique National de Belgique, Meise, Blegium - 22 taxa
Botanischer Garten Bonn, Germany - 20 taxa.
Royal Botanic Garden, Edinburgh, U.K. - c. 20 taxa.
Museum National d'Histoire Naturelle, Paris, France - 16 taxa.
Botanischer Garten Mainz, Germany - 14 taxa.

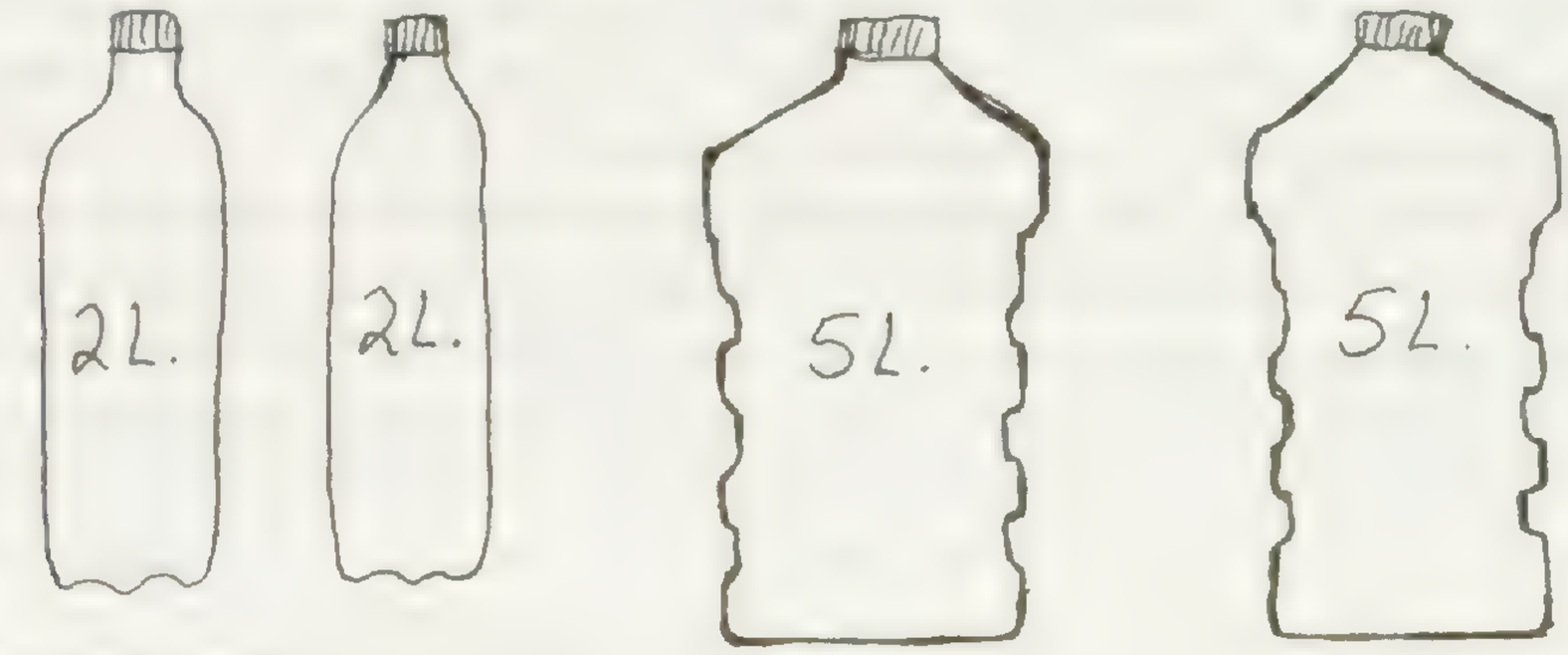
The National Collection of Selaginella is held at the Barbican Conservatory, Barbican Centre, Silk street, London. Nearest tube stations - Barbican, Moorgate. Open by appointment only, please phone 0171 638 6114.

ACKNOWLEDGEMENTS

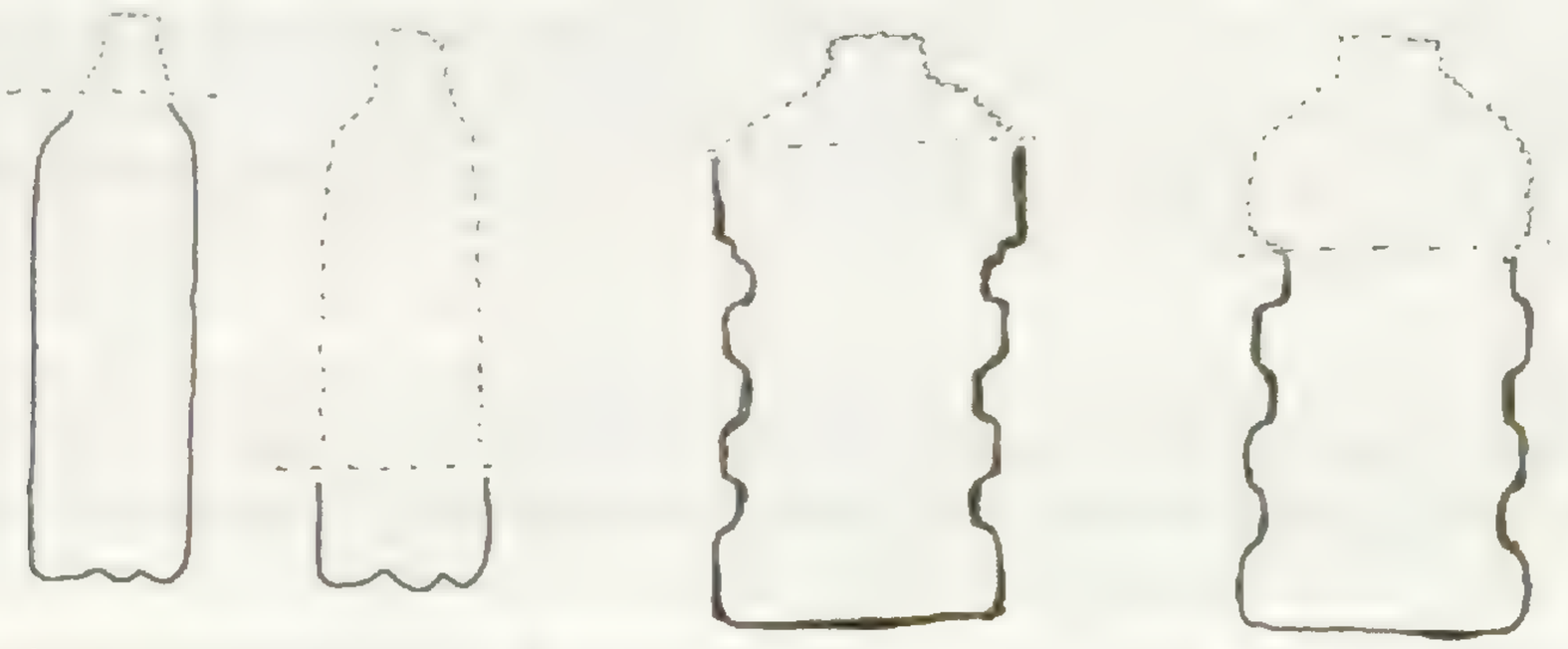
The author would like to express his thanks for their help in this article to Josephine Camus, Amela Secerbegovic and Chad Husby.

There are 620 National Collections in the UK, co-ordinated by the national Council for the Conservation of plants and gardens (NCCPG). Fern Growers wishing to make a collection should contact: NCCPG, The Stable Court Yard, RHS Garden, Wisley, Woking, Surrey GU23 6QP

Fig. How to make a plastic bottle-garden.



Step 1.Two plastic bottles of equal size.



Step 2. Each bottle has it's top cut off, one at the widest point, and one below the widest point, so that the widest point can then be inverted to slip over the second bottle with narrower neck.

Step 3. Place the plant in it's pot within the container and put the cut off bottle with the widest point over the second bottle.

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ELIZABETH BLACKWELL'S CURIOUS HERBAL

Barry A. Thomas, Geography Department, University of Wales Lampeter, Lampeter, Ceredigion SA48 7ED

The early 18th century saw the publication of many fine illustrated books on plants and there was clearly a market for them. Against this desire for such books Elizabeth Blackwell decided to paint her beautiful plant portraits of plants used in herbal medicine. She was desperate for money because her husband was locked up in a debtors' prison. This idea of course did not just suddenly come upon her. Elizabeth Blackwell was the daughter of as merchant family and therefore from a prosperous background, but more importantly she was the niece of the Professor of Medicine at Glasgow University. Doors were therefore opened for her in a way that would have been impossible otherwise and she received help and encouragement from a wide range of botanists, physicians and apothecaries. The Worshipful Company of Apothacaries promoted her work so Elizabeth Blackwell moved to the vicinity of their Chelsea Physic Garden in London where she was given the plants for her illustrations. Her work was eventually printed in weekly parts for eventual binding as:

A CURIOUS HERBAL *Containing* FIVE HUNDRED CUTS *of the most* useful Plants, *which are now used in the Practice of* PHYSIC. *Engraved on folio Copper Plates after Drawings, taken from the* LIFE. *By Elizabeth Blackwell. To which is added a short Description of ye* Plants *and their common Uses in PHYSICK*. Vol.I. London. *Printed for* Samuel Harding in St. Martin's-Lane, M.D.CC.XXXVII. Vol.II. London. *Printed for* John Nourse *at the Lamb without* Temple Bar, MDCCXXXIX

All of the illustrations had hand written engraved pages of explanation preceding every four plates. Some of these descriptions were copied from the work of Joseph Miller, Master of the Worshipful Company of Apothecaries of London, who no doubt helped in the identifications and supplied her with samples of plants.

Many of these printed page inserts have their own woodcut headings with crests and other drawings because over 50 people had given their approval to the work. These included some very famous people of the time: Richard Meade MD Physician in Ordinary to his Majesty and Fellow of the Royal College of Physicians of London and Fellow of the Royal Society; Thomas Pellet M.D. President of the Royal College of Physicians of London and fellow of the Royal Society; Sir Hans Sloane Bart. M.D. Physician in Ordinary to her Majesty and President of the Royal Society; Alexander Stuart M.D. Physician in Ordinary to her Majesty and Fellow of the Royal College of Physicians and the Royal Society of London; Robert Nicholls Apothecary. Isaac Rand Apothecary and Fellow of the Royal Society of London; James Douglas M.D. Physician in Extraordinary to her Majesty, Honorary Fellow of the Royal College of Physicians of London and Fellow of the Royal Society; Henry Plumptre M.D. & F.R.S.

It certainly had the seal of approval because one of the Censors of the Royal College of Physicians of London wrote in the book *Your ready Concurrence with the President and other Censors of the Royal College of Physicians of London in recommending by their Licence this work to the public and great Goodness to me in Promoting its Acceptance among your Friends and Acquaintance*. John Johnsoune M.D. Professor of Physick in the University of Glasgow (presumably Elizabeth Blackwell's uncle) actually thanked Joseph Miller for making it acceptable in Glasgow.

The illustrations are rather good although there certainly are mistakes in the descriptions.This is surprising because, although Elizabeth Blackwell was clearly no botanist, she was being supplied the plants by the apothecary Isaac Rand who was in charge of the Chelsea Physic Garden. Unfortunately there are only thirteen ferns and one horsetail included in her epic work. These are (modern names): *Aplenium adiantum-nigrum* L., *Adiantum capillus-veneris* L., *Asplenium ruta-muraria* L., *Asplenium scolopendrium* L., *Asplenium trichomanes* L., Botrychium lunaria (L.) Sw. *Cibotium barometz* (L.) Snith. *Dyropteris filix-mas* (L.) Schott]. *Equisetum arvense* L., Ophioglossum vulgatum L., *Osmunda regalis* L., *Polypodium vulgare* L., *Pteridium aquilinum* (L.) Kuhn.

A Curious Herbal was well received in Britain and on the continent and an eventually another version appeared with latin text in 1750-1760 as the *Herbarium Blackwellianum* edited by Christoph Jakob Trew in Neuremberg.

Copies of A Curious Herbal are in the libraries of: The National Museum and Gallery of Wales, Cardiff, the Linnean Society of London (uncoloured copy), The Royal Botanic Garden, Edinburgh and The Royal Botanic Gardens, Kew. A copy of the *Herbarium Blackwellianum* is in the Royal Botanic Gardens, Kew.

The plates figured here were photographed from the copy held at The National Museum and Gallery of Wales, Cardiff. Their descriptions are:

7th November 1737: Plate 323. Male Fearn. Filix mas. [*Dyropteris filix-mas* (L.) Schott]. The Root is said to be hurtful to the Female Sex, and to cause miscarriage: but is accounted good for Obstructions of the Liver and Spleen. *Latin*, Filix non ramosa dentata. (Fig. 1).

7th November 1737: Plate 325. Female Fearne or Brakes. Filix foemina. [*Pteridium aquilinum* (L.) Kuhn]. The Roots are accounted good for Worms, especially the Lumbricilati. Some make a kind of Pot-Ash from the stalks & Leaves burnt. *Latin*, Filix ramosa major, pinnulis obtusis, non dentatus.[The description of the leaves and its growing habitats confirm that Bracken and not Lady Fern is being described which accounts for the illustration. The name given must have been a mistake.] (Fig. 2).

Fig. 1 Plate 323. *Dryopteris filix-mas*

Fig. 2 Plate 325. *Pteridium aquilinum*

HUPERZIA SELAGO IN CORNWALL

Rosaline J. Murphy, 'Shang-ri-la', Reskadinnick, Camborne, Cornwall TR14 OBH
and Ian J.Bennallick, Lower Polmorla, St.Wenn, Bodmin, Cornwall PL30 5PE

Huperzia selago (L.) Bernh. ex. Schrank & Mart., the Fir Clubmoss, has always been rare in Cornwall so its recent discovery at two new locations in the county prompted this note. Although recorded in the past for such places as Witheybrook near the Cheesewring (SX27), St George Downs near Perranporth (SW75) and Goonhilly Downs on the Lizard (SW75), it is often no longer to be found at these sites (Fig.1). Apart from the brief statement 'boggy and heathy places' (Davey,1909), indications of the nature of the habitat are few and such records also lack any note concerning the number of plants at any one site.

Only on the Lizard has the species survived in any great numbers, though plants recorded between 1950 and 1966 were destroyed by repeated summer fires and it was feared that *Huperzia selago* was lost from here (Frost, 1983). However, both mature and immature plants were seen in new populations found in 1983 and 1984, though one of these was subsequently lost, again in a summer fire. In this area of Cornwall the clubmoss grows in short wet heath (the *Agrostis curtisii* variant of *Erica vagans* heath: National Vegetation Classification, H6 [Rodwell et al 1991]) and it is interesting to note that these sites are within National Nature Reserves.

In 1973 Fir Clubmoss was found once more on Badgall Downs (SX28) and in 1978 it was located on Kilmar Tor (SX27), but it has not been seen at either of these places since then. A further site was found in 1979, this time on Rough Tor (SX18) where it may still grow. Paul Gainey searched this area in 1988 and saw just one plant growing on the north slopes of the Tor, in somewhat bare ground within the granite clitter, but not in deep shade.

The plants found most recently would seem to be survivors from further populations. One was seen in a disused slate quarry near Trewarmett (6 October 1998) and the other on old china-clay waste near Treskilling Downs (19 October 1998). In both cases they were growing in situations that gave them a degree of natural protection. At Trewarmett the clubmoss was growing between two fallen slates on a slight scree-slope backed by a steep rock face. At Treskilling Downs the plant grew out from under a china-clay drainage pipe giving it vital protection from the intensive grazing of rabbits. In both cases the associated plants were few, merely *Rumex acetosella*, *Vaccinium myrtillus* and bryophytes in the quarry though there was some heath nearby and much *Salix* scrub around the pool below the slates. At Treskilling the vegetation was sparse and closely nibbled, with *Agrostis capillaris*, *Calluna vulgaris*, *Erica cinerea*, *Rumex acetosella* and bryophytes colonising the damp sandy gravels of china-clay. Both plants were mature, bearing 2 or 3 bands of sporophylls but no gemmae were seen (Fig.2). It could be that the gemmae were dispersed before the October when the plants were found, but observations on Welsh material indicate that this may not happen until December (Iliff, 1991). As it is argued that gemmae are the main or even the only method of reproduction in *Huperzia selago* (Clapham Tutin & Moore, 1987; Page, 1997), the lack of gemmae can be regarded as important and may account in part at least for the rarity of the plant in Cornwall. It poses the question as to the conditions under which gemmae are produced. Either gemmae or spores could lodge between the slates in the quarry and the gemmae at least might then give rise to new plants but this does not seem to be happening. Open sites are good for spore germination and the production of the subterranean prothalli. This is possible on the Lizard, but doubtful in the conditions within the quarry and at the china-clay locality.

A distribution map based on a 10 km^2 scale does not give a sufficiently accurate impression of the present state of *Huperzia selago* in Cornwall. On the Lizard there are many plants still able to maintain viable populations (Byfield & Hughes, 1984) and observations made by Paul Gainey confirm that these plants do produce gemmae. Over the rest of Cornwall, however, there are at present just three plants known so this stresses the importance of their presence on the Lizard.

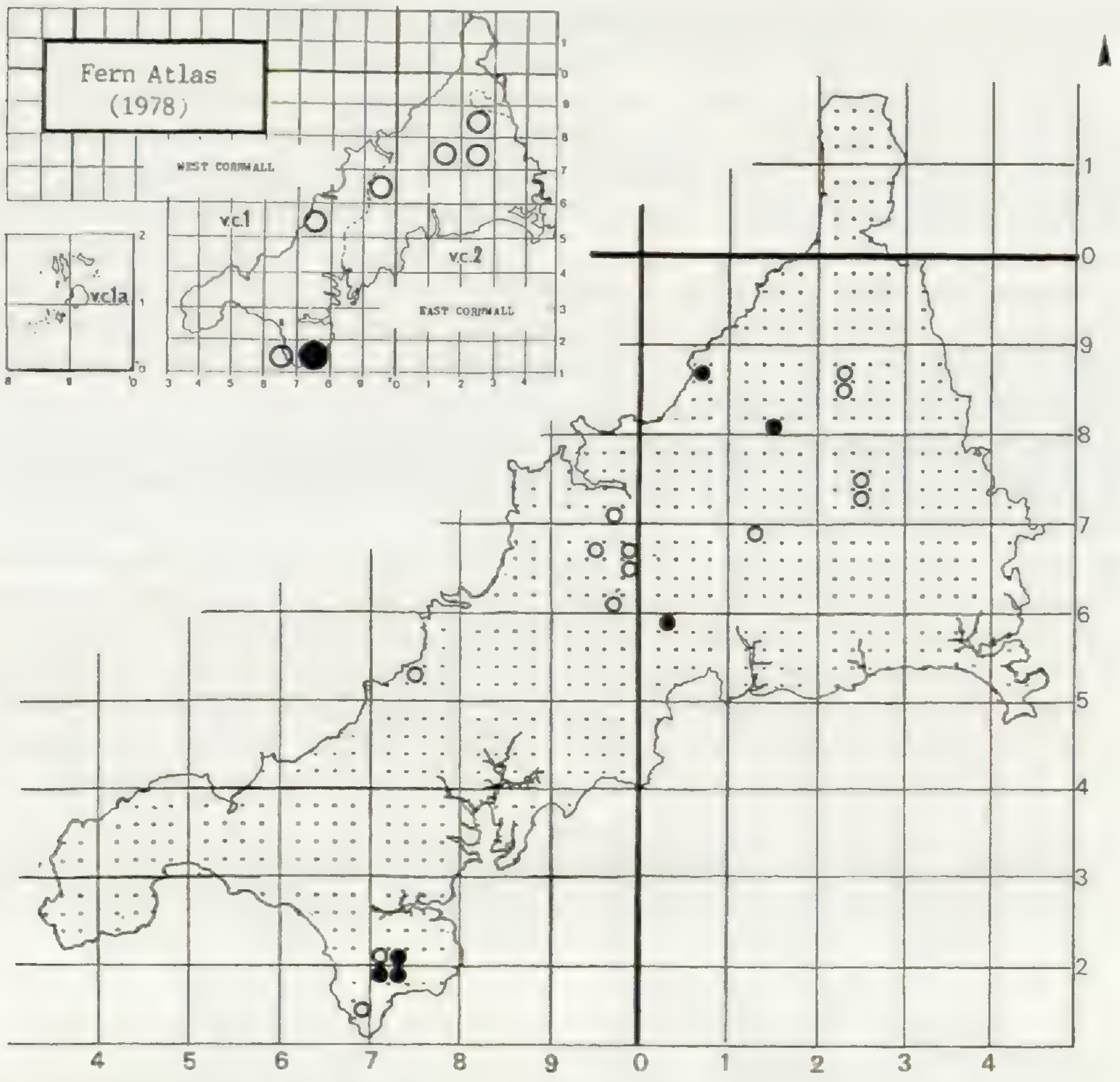

Fig. 1 Distribution of *Huperzia selago* in Cornwall. Sites on the larger map, marked with an open circle are for records that are pre-1980.

Fig. 2 *Huperzia selago* from old slate quarry, near Trewarmett, Cornwall. VC2 - 6 October 1988

ACKNOWLEDGEMENTS

We would like to thank Arthur Chater for drawing our attention to the article on clubmosses by J. Iliff, to Paul Gainey for information on gemmae production in *Huperzia selago* on the Lizard and to Clive Jermy for many helpful comments.

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BOOK REVIEW

FERNS OF THE TROPICS by Wee Yow Chin. Times Editions Pte Ltd, Singapore. 1997. 190 pp., 208 colour plates, 14 figures. ISBN 981 204 793 X. Hardback: £15.97; paperback: £9.95.

The first 85 pages of this book are given to a resumé of fern morphology, followed by chapters on ferns in folklore and superstition, economic uses, propagation, and cultivation. The text is clear and very readable, although, sometimes, somewhat simplistic in some areas. Although the title of the book suggests tropical ferns, information on uses and folklore pull heavily on examples from Europe and other temperate areas and an atypically poor photograph of *Dryopteris filix-mas* in a botanic garden is given to illustrate such a point. It is, nevertheless, an interesting account and will help to widen the readership. The account on spore culture includes a short piece on tissue culture but that on garden culture, including pests and diseases and fertilisers, is disappointingly scant. I found the chapter on habitats better and here the field botanist in the author begins to emerge.

The bulk (some hundred pages) of the book is briefly describing some 77 Malaysian ferns and their allies. Each species is illustrated by one or several beautiful photographs. These photographs are obviously taken by a botanist who knows the points that he wants to illustrate, as general habit, portrait and close-up shots. Particularly interesting shots include a microscopic section of an *Ophioglossum* root, showing the fungal mycorrhiza, and some impressive epiphyte assemblages. The fact that botanist is also a highly skilled photographer, both technically and artistically, gives a very good value for your money. Further hints on how to cultivate each species, when appropriate, and some diagnostic features are given in the text. For anyone wanting a pictorial review of a slice of a tropical fern flora, this is the book.

Clive Jermy

THE SURVIVAL OF DORMANT FERN SPORES

Kate Simpson and Adrian Dyer
Institute of Cell and Molecular Biology, University of Edinburgh, Rutherford Building, The King's Buildings, Mayfield Road, Edinburgh EH9 3JH,

INTRODUCTION

While much attention is understandably directed towards the dynamic stages of the fern life cycle, the dormant spore has remarkable properties. As the dispersal agent responsible for establishing new sexually-produced individuals at new sites, the spore has to carry the potential for producing all the structures of both generations of the life cycle, the gametophyte and the sporophyte. A spore is a single cell so small that up to about 100 could be placed on a newsprint full-stop. Yet it contains the stored nutrients such as carbohydrates, proteins and lipids, necessary for the initial stages of germination before the gametophyte becomes self-supporting, and also contains the genetic information to produce in sequence two quite different plants, for example a tree fern 15m high and a prothallus 1cm wide.

The spore is non-motile, so external vectors have to be exploited to achieve dispersal. The small size and mass of a spore allow it to be carried passively by air currents, once the explosive action of the sporangium has projected it away from the leaf surface, although differences in shape, volume and surface ornamentation will affect dispersal range.

The spore is apparently capable of germination immediately on release but it is kept dormant during dispersal because of the absence of conditions required for germination. However, if a spore is to be capable of establishment after long-distance dispersal, it must remain viable despite the onslaught of adverse conditions; extremes of drought, low temperature and U-V irradiation will be experienced, especially at high altitudes and perhaps for many days. If the conditions are still unsuitable for germination after the dormant spore is deposited, the chances of eventual establishment are enhanced if it can continue to remain viable for an extended period. This requires spores to survive conditions which are too dry, too cold or, after penetrating the soil, too dark for germination. In some habitats, establishment will also depend on the ability to survive microbial attack and grazing by invertebrates (Conway, 1953; Schneller, 1979) and, perhaps, high temperatures generated by fire.

Information about the effect of external conditions on the viability of dormant fern spores is limited and unevenly distributed. Fern spores have been recorded in air samples taken at various altitudes over land and sea (Page, 1979; Anderson, 1985; Yasmeen and Devi, 1988) but their viability has not been tested; most bryophytes spores were killed by exposure of a few hours at altitudes of about 35,000 feet (van Zanten and Gradstein, 1988). Although UV irradiation has been used to induce mutations in spores (Kato, 1964; Partanen and Nelson,1961), there is little information on its effect on viability, even in experimental conditions (Charlton, 1938; Kato, 1964; Miller, 1968; Page, 1979). It does appear, however, that dormant spores are less sensitive to UV than cells of growing gametophytes.

Spores of some species survive in laboratory or herbarium storage at room temperature for several decades (Sussman, 1965; Dyer, 1979; Page, 1979; Raghavan, 1989), indicating a degree of tolerance of desiccation, but there are few long-term storage experiments on desiccation effects and one of them revealed that 'air-dry' storage reduced the longevity of spores compared with that of imbibed (hydrated) spores (Lindsay, Williams and Dyer, 1992). Extensive experimentation on several species indicates that spores of most ferns require light to initiate germination (Raghavan, 1989) but there is no information on the effect, if any, of light on the longevity of spores kept dormant by lack of water or low temperature.

There are almost no observations on spore longevity under soil conditions. Buried bracken (*Pteridium aquilinum*) spores do not survive long. Conway (1953) observed that the germination percentage after 14 months was 19.7% for buried spores compared with 65.5% for dry-stored spores, while Dyer (unpubl.) recorded germination percentages after 10 months of 2.1% for buried spores and 63.0% for dry-stored spores. However, bracken is unusual in having a short-lived spore bank (Lindsay, Sheffield and Dyer, 1994) and its spores might be unusually susceptible to attack by soil micro-organisms. It is known that spores can survive passage through the gut of earthworms (Dyer and Lindsay, 1992).

The protective qualities of the relatively thick, often pigmented, wall probably contribute significantly to the tolerance by spores of some of these adverse conditions, including drought, UV irradiation, microbial attack and, perhaps, grazing. This is made all the more remarkable by the fact that the wall must at the same time allow the spore to respond rapidly when conditions are subsequently suitable for germination. As, in many species, germination is mediated by phytochrome in imbibed spores, this requires that the wall, while retaining its ability to protect, is permeable to water and transmits red light.

Tolerance to temperature extremes must be a property entirely of the cytoplasm rather than of the spore wall. There is considerable evidence that viability is prolonged at lower temperatures in refrigerators (e.g. Dyer, 1979; Page, 1979; Sussman, 1965; Raghavan, 1989). After 12 months air-dry storage at 20°C, all the spores of *Polystichum setiferum* were dead, but after storage at 4°C, the viability (maximum percentage germination) had only fallen from 61% to 53%; spores of *Athyrium filix-femina* stored in similar conditions for 2 years showed a reduction in viability from 84% to 13% at 20°C but only fell to 72% at 4°C (Lindsay and Dyer, unpubl.). Spores have been successfully stored in deep-freezes, indicating that dormant spores of at least some species can survive sub-zero temperatures, though they may become more sensitive to freezing once imbibed. Spores of *Cyathea spinulosa* remained viable after storage in liquid nitrogen (-196°C) (Agrawal, Pawar and Mascarenhas, 1993) and those of *Dryopteris filix-mas* germinated after 11 hours at -270°C in liquid helium (Becquerel, 1930).

There is much less information on the effects on spore viability at high temperatures. Investigation of the effects of high temperature on germination provides some insight into the effects of short periods of such conditions on the viability of imbibed spores. Conway (1949) found that bracken spores not only failed to germinate but failed even to swell and turn green after 28 days on germination medium at 35°C, indicating that they might have died, though no viability tests were carried out. Failure to germinate at 40°C for *Onoclea sensibilis* (Hartt, 1925) and at about 35°C for *Adiantum pedatum*, *Thelypteris palustris* and *Woodwardia virginica*, (Hill, 1971) indicate similar limits for these species. However, spores of several desert ferns, including *Cheilanthes lindheimer* and *Notholaena cochisensis*, germinate after a few days at 40-50°C and survive without germinating for up to a week at temperatures 5-10°C higher than this (Hevly, 1963), indicating a greater tolerance of high temperatures.

There are very few studies of the effects of high temperature on dry dormant spores. Dry storage at temperatures of 55°C and 62°C for up to 140 days caused post-germination growth abnormalities and eventually spore death in several species (Rottman, 1939). For example, for *Pteris serrulata*, percentage germination was reduced from 59.4% to 4.7% by dry storage for 110 days at 62°C. Some new observations on the remarkable tolerance of dormant spores to high temperature are described below.

THE EFFECT OF HIGH TEMPERATURES ON THE VIABILITY OF DORMANT SPORES OF *CRYPTOGRAMMA CRISPA*

In an experiment to monitor the movement of spores in the soil during the formation of spore banks, marker spores were sown on the soil surface. Spores of Parsley Fern (*Cryptogramma crispa* (L.) Hook.) were used because their morphology allowed them to be distinguished from all other British species and this species did not occur naturally in the vicinity of the experimental field site in Roslin Glen Wildlife Reserve, Midlothian, Scotland. In order to avoid any risk of artificial introduction of a new species into the Reserve, the spores had to be killed before they were sown. Because the spores had to be in a condition suitable for dry sowing, high temperature was chosen as the method to kill them.

The spores used had been stored dry at 4°C for about 6 months. Spores were tested for viability by sowing them on a culture medium (Dyer, 1979) solidified with Phytogel (Sigma Chemical Co.) and then examining them for germination over a period of a further 25 days. Rhizoid emergence was taken to indicate viability. Germination of stored but otherwise untreated spores was first seen after 7 days culture and reached the maximum value of 98% after 19 days. Clearly, the viability of these spores was unaffected by storage.

Initially, dry spores in covered porcelain dishes were subjected to a temperature of 70°C in the dark in an electric oven for various periods up to 288 hours (12 days). After 4 hours heat treatment, full germination (98%) occurred within about 20 days (Fig.1). After 24 hours, germination was slower and only 85% were viable but after 72 hours treatment, over 30% of the spores were still viable, and a few survived 288 hours (12 days) at 70°C. Because an effective treatment at 70°C would therefore be inconveniently long, other more rigorous conditions were tried.

It was conjectured that spores might be more sensitive after imbibition, so they were imbibed in water before heating at 70°C. They were immersed in water for 48 hours, by which time they had expanded from a mean diameter of 48.45μm to one of 54.58μm. Spores on Phytogel medium reach a mean diameter of 54.58μm by the time they germinate, so the spores imbibed in water were assumed to be almost fully imbibed after 48 hours. Germination tests after heat treatment showed that, contrary to expectation, imbibed spores were more resistant than dry spores (Fig.2). After 24 hours at 70°C, there was no reduction in viability, which remained at about 97% (compared with about 85% for dry spores) and after 96 hours, viability was 85% (compared with 30% after only 72 hours for dry spores).

The spores were also resistant to heating in a 800W microwave oven. Over 65% of the dry spores were still viable after 30 minutes treatment, indicating that long periods of microwave irradiation would be required to kill all the spores.

Subsequently it was found that 48 hours at 100°C in an electric oven was an effective and convenient treatment that killed all the spores.

DISCUSSION

The observation that spores of *Cryptogramma crispa* survive 24 hours at 70°C with no loss of viability raises the question of whether this could be of adaptive value. It could only be so if such temperatures were experienced in nature. Temperatures of 40-50°C have been recorded for a few hours in early afternoon in dry soil alongside *Asplenium septentrionale* and *Woodsia ilvensis* in crevices of dark, south-facing rocks in Scotland and Norway in summer (Dyer, unpubl.), and it is possible that higher temperatures are reached at lower latitudes. Hevly (1963) indicated that peak temperatures as high as 60°C are encountered by desert ferns in southern Arizona, USA. However, *C. crispa* is an upland species 'avoiding conditions of high summer maximum temperatures' (Page, 1982) and is thus perhaps unlikely to experience such temperatures through insolation. Much higher temperatures are created by fire: peak temperatures from 140-180°C have been recorded at the soil surface in heath fires (Hobbs and Gimingham, 1987) and similar temperatures occur during forest fires (Whelan, 1995). However, in the typical habitat of *C. crispa*, an open, upland scree with little or no other vegetation, fire is unlikely. It would seem, therefore, that the tolerance to high temperature is an unselected characteristic in this species, perhaps an inevitable consequence of physiological dormancy and the ability to survive other extreme conditions during and after dispersal, and thus a characteristic shared by other fern species.

Some other fern species live in habitats more prone to fire. Although much more investigation is required, it is possible that spores of at least some of these species are equally capable of surviving short periods of high temperature. In heath fires, temperatures above 100°C at the soil surface rarely last more than 2 minutes (Hobbs and Gimingham, 1984) but may nevertheless be sufficient to kill exposed spores. However, temperatures at 2.5 cm below the soil surface rarely exceed about 70°C during heath or forest fire (Hobbs and Gimingham, 1984; Whelan, 1995) and in damp soils cannot exceed 100°C until all the water has been evaporated off. Buried spores in many habitats will be imbibed. Any spores capable of surviving 24 hours at 70°C with no loss of viability, like the imbibed spores of *C. crispa*, will therefore survive a fire passing rapidly over them if they are more than a few millimetres below the surface. It is therefore no surprise that a live spore bank has been detected in the surface layers of the soil after both heath and forest fires (Dyer and Lindsay, 1992). The surviving heath spore bank contained live spores of *Blechnum spicant* and *Dryopteris* species (Dyer, unpubl.).

Some ferns survive fire as mature sporophytes. Even in Britain, *Blechnum spicant* regenerates readily after muirburn which kills all the above-ground branches of heather (*Calluna vulgaris*) (Dyer, unpubl.). In *Blechnum*, rhizome tips close to the soil surface are protected by dead frond bases. In seasonally arid habitats like the cerrado of Brazil, where periodic fire is an important component of natural conditions, sporophytes of many of the native ferns are adapted in one way or another to protect growing points from the heat. However, even in these species, the ability of buried spores to survive fire near the soil surface might provide an important additional means of regeneration. The results of some simple experiments on the effects of high temperature on dormant spores of these species would be of particular interest in this regard.

If the ability to survive high temperature treatments is a common feature of fern spores, it might have a practical application for fern growers. If spores of ferns are more tolerant of high temperatures, either before or after imbibition, than those of fungi and other organisms present on the fern spore surface, heat treatment might provide an alternative, simple, chemical-free, method of reducing contamination in gametophyte cultures. We have support for this idea from a preliminary experiment involving *Asplenium ruta-muraria*. Experimental cultures of a sample of spores of this species were unusually heavily contaminated with fungi but after treating the spores at 70°C for 24 hours before sowing, this contamination was noticeably reduced. Treatment of imbibed spores might be even more effective.

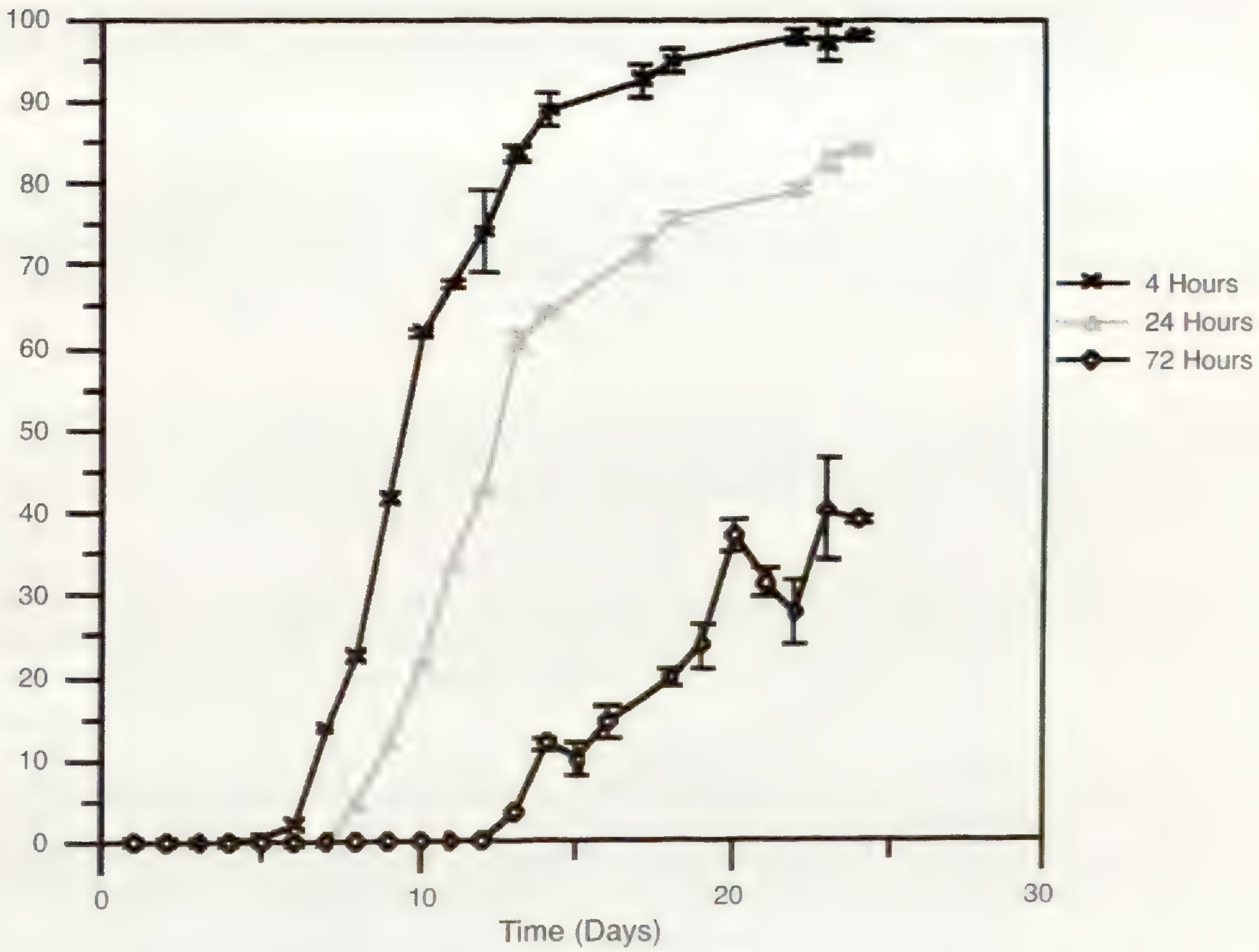

Figure 1. Germination curves (percentage germination plotted against days after sowing) of dry spores of *Cryptogramma crispa* after 4, 24 and 72 hours heat treatment at 70°C. After 144 and 288 hours treatment, fewer than 5% of spores had germinated after 28 days in culture.

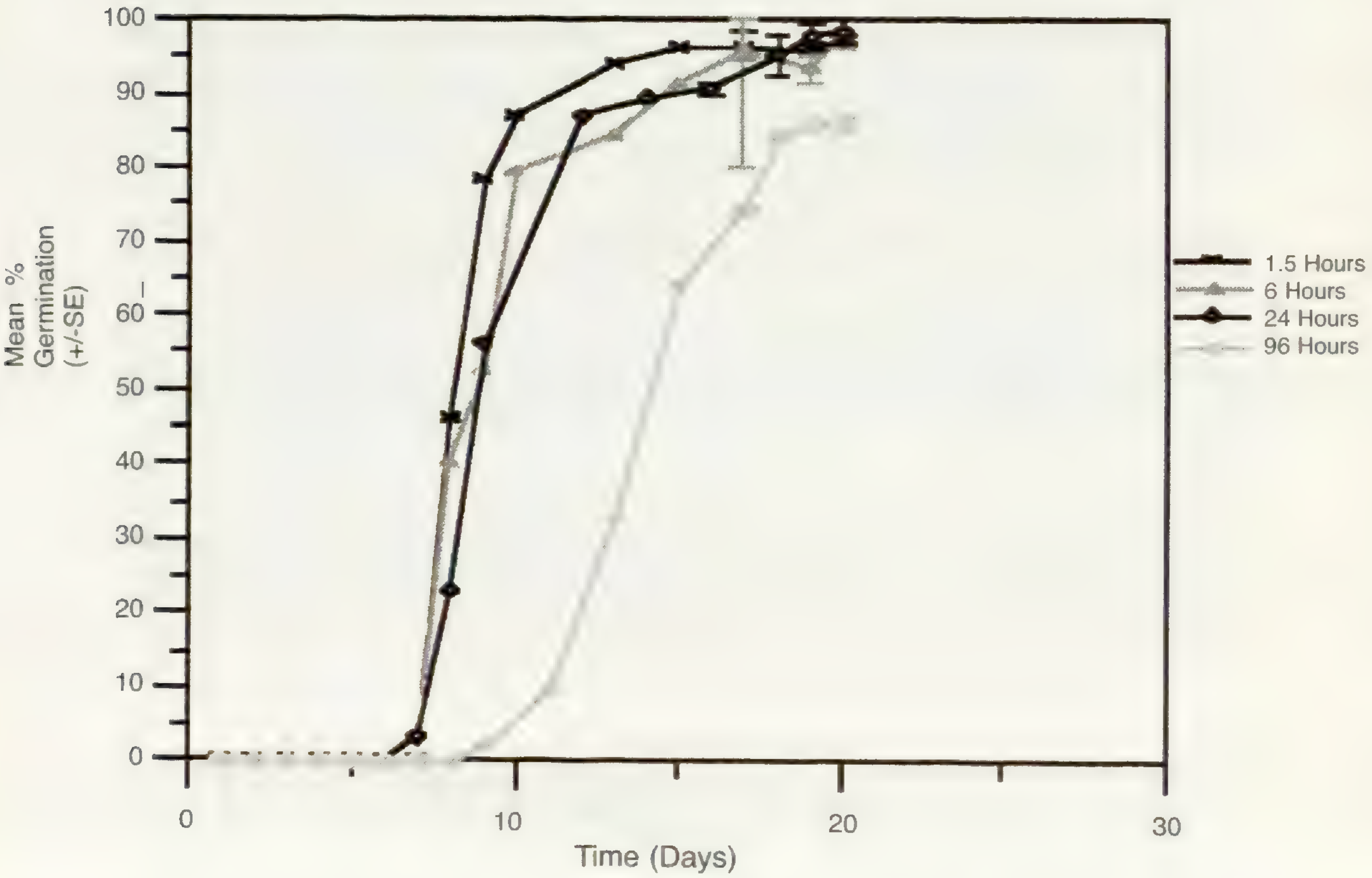

Figure 2. Germination curves (percentage germination plotted against days after sowing) of imbibed spores of *Cryptogramma crispa* after 1.5, 6, 24 and 96 hours heat treatment at 70°C.

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BOOK REVIEWS

LET'S TASTE ALASKA by Mary Carey. Tex-Alaska Press. Third edition. 1996. 87 pp. $6.95 (p&p. $1.50). [No ISBN; order from Mary Carey, HC Box 8540, Talkeetna, Alaska 99676-9705, U.S.A.]

The author describes herself as a crackpot journalist, although others have called her an amazing grandmother. Mary has served up fiddlehead fern specialities at her McKinley View Lodge for many years and has her own Fiddlehead Fern Farm from where she supplies a select number of restaurants.

The book is a wonderful mixture of recipes, very readable anecdotes and pleasant drawings. Even though there are only 14 pages on fiddlehead recipes there is plenty of choice ranging from *fern and onion soup* to *chilli-fern sandwich*, *deep fried fiddleheads in beer batter* and *fern, macaroni ad cheese casserole*. The rest of the book gives you further choices from Alaskan fish dishes, moose, caribou, rabbit and grouse to breads, jams and desserts. An all round interesting little book.

For a further $1.50 Mary Carey sells 'Fiddlehead Fern Seeds' - two fertile fronds in a packet with 'planting instructions' to her customers that call into her restaurant.

Barry A. Thomas

NOTEWORTHY FERNS OF THAILAND. T. Boonkerd. Chulalongkorn University Press, Thailand (http://www.cubook.com), 1996. CD ROM. Recommended price 1,500 Thai Baht (approx. £25); apparently on offer at 500 Thai Baht.

Treat yourself to a dream of a fern holiday in Thailand with this multimedia presentation in English designed for a 486 (or higher) PC running Windows 3.1.

A nine minute animated demo introduces the potential of the first multimedia CD or electronic textbook to be produced by Chulalongkorn University, based on the author's 20 years experience of ferns. The team are to be congratulated on their work.

This work will introduce the student to the life cycle of ferns and the variety of form, the novice horticulturist to propagation techniques and the fernophile to the diversity of ferns to be found in Thailand. There is a map showing the choice ferny places to visit, and a brief introduction to the phytogeography of mainland SE Asia. A library of splendid colour plates of 120 species of ferns are accompanied by text of family, scientific name, common name, Thai name and a description. This library comprises all the genera, but only about one quarter of the species of the Thai fern flora, thus providing an excellent overview. Point-and-click word definitions link the text to the comprehensive glossary. Conservation and uses of ferns are also covered, and a good bibliography is included.

There is not a key at any level to the different ferns, and fern allies are not included.

Those captivated by book publications on Malaysia, Singapore, Hong Kong and the Philippines will be equally enchanted by this offering and pressure will surely grow for a BPS Excursion to SE Asia.

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